INSTRUCTION MANUAL

PANORAMIC
TELEMETERING INDICATOR, MODEL TMI-1b
TELEMETERING POWER SUPPLY, MODEL TMP-1b
TELEMETERING SUBCARRIER DEVIATION AND THREE POINT CALIBRATOR, MODEL TMC-1a

Gertsch*
EMPIRE*
Sensitive Research*
Panoramic*
SINGER

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Precision electrical and electronic instruments for measurement

THE SINGER COMPANY • METRICS DIVISION

INSTRUCTION MANUAL

FOR

PANORAMIC
TELEMETERING INDICATOR, MODEL TMI-1b
TELEMETERING POWER SUPPLY, MODEL TMP-1b
TELEMETERING SUBCARRIER DEVIATION
AND THREE POINT CALIBRATOR, MODEL TMC-1a

Panoramic
INSTRUMENTS

Manufactured by

SINGER METRICS
DIVISION
THE SINGER MANUFACTURING COMPANY
915 PEMBROKE STREET • BRIDGEPORT 8, CONNECTICUT

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Date..... CONDITION ON ARRIVAL.....

FIELDS OF APPLICATION: .....

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COMMENTS: .....

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March 26, 1964

ADDENDUM FOR COMPOSITE MANUAL

TMI-1b, TMP-1b, AND TMC-1a

I. PURPOSE

The purpose of this addendum is to list corrective information that should be included in this manual.

II. ADDENDUM

A. On page 23, table 2, step 4:

Change: "2 wire ac line cord"

to read: "3 wire ac line cord, Singer No. 04-556161-066."

B. On page 93, J902:

Change circuit reference symbol manufacturer from "Harvey Hubbell 7486"

to read: "J902 - Seegar Williams No. 6"

Addendum No. 253

ADDENDUM FOR TMI-1b

I PURPOSE

The purpose of this addendum is to supply information about Sola transformers supplied with regular and special inputs.

II ADDENDUM

The Sola transformer that goes with the standard 115 volt input as well as Sola transformers that go with other voltage inputs are listed as follows:

Input Voltage	Volt Amperes	Output Volts	Input Frequency	Panoramic Part No.	Singer Part No.
95 to 130	250	118	60 cps	T-3017-1	556160-117
95 to 130	250	118	50 cps	T-3030-1	556160-118
190 to 260	250	118	50 cps	T-3031A-1	556160-119
380 to 520	250	118	50 cps	T-3031A-1	556160-119

5-12-64
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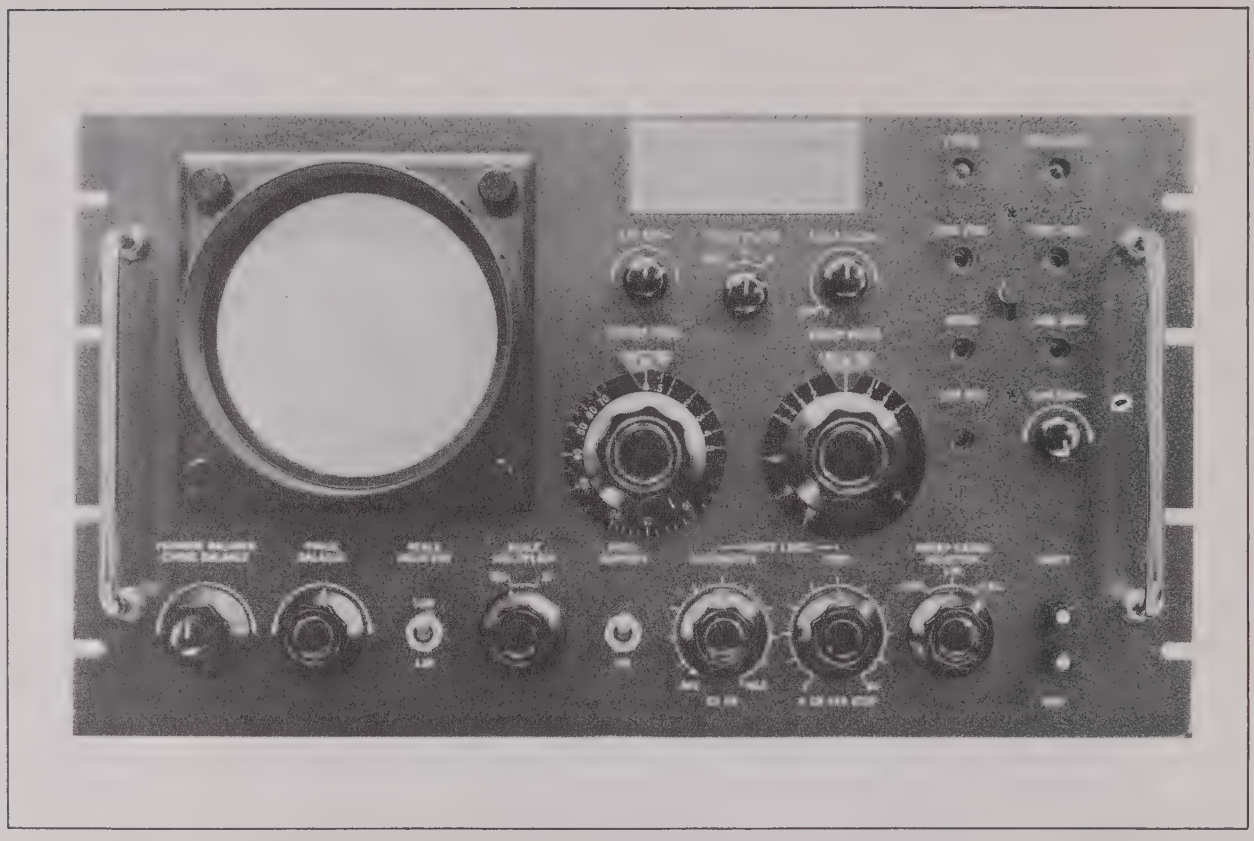

Figure I-1a. Panoramic Telemetering Indicator, Model TMI-1b.

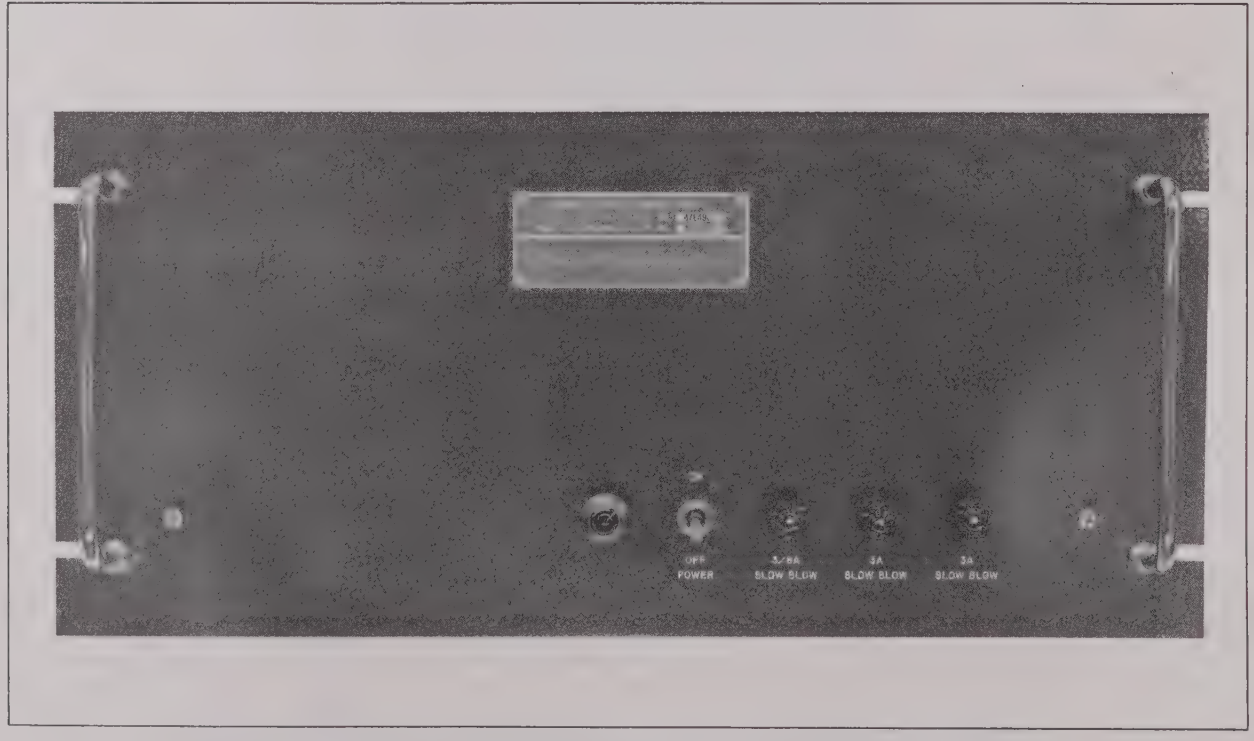

Figure I-1b. Panoramic Telemetering Power Supply, Model TMP-1b.

CHAPTER I
INTRODUCTION

I-1. GENERAL

This Instruction Manual contains information concerning electrical and physical characteristics, applications, installation, and operation of the Panoramic Telemetering Indicator, Model TMI-1b, its associated power supply, the Panoramic Telemetering Indicator Power Supply, Model TMP-1b, and the Panoramic Telemetering Subcarrier Deviation and Three Point Calibrator, Model TMC-1a, as well as information concerning maintenance and servicing of the Models TMI-1b, TMP-1b, and TMC-1a.

No attempt to operate the equipment should be made until the user is thoroughly familiar with the information contained in Chapter III, - OPERATING INSTRUCTIONS.

I-2. APPLICATIONS

The combination of the Panoramic Telemetering Indicator, Model TMI-1b (with associated power supply, Model TMP-1b) and the Panoramic Telemetering Subcarrier Deviation and Three Point Calibrator, Model TMC-1a provides a simple, reliable method for checking system operation, channel center frequencies, and channel limits in the IRIG approved FM/FM telemetry system.

Used by itself, the Model TMC-1a can provide crystal-derived marker signals for discriminator alignment.

The Panoramic Model TMI-1b (with associated power supply) can be used to monitor the entire telemetry sub-carrier band to confirm the presence of sub-carriers in the operating channels and to check their operating levels. The equipment is able to display the channel location and level (relative to sub-carrier amplitude) of noise, intermodulation distortion and other spurious effects, down to magnitudes insufficient to disturb system operation. The presence of disturbing signals from sources other than the telemetry system can be seen at a glance. In order to examine the entire telemetry band, a full-coverage logarithmic-frequency presentation is utilized.

In order to obtain a minute examination of single channels or groups of adjacent channels, the TMI-1b can be readily conditioned to select for presentation a portion of the telemetry band. This is particularly useful when the system usage

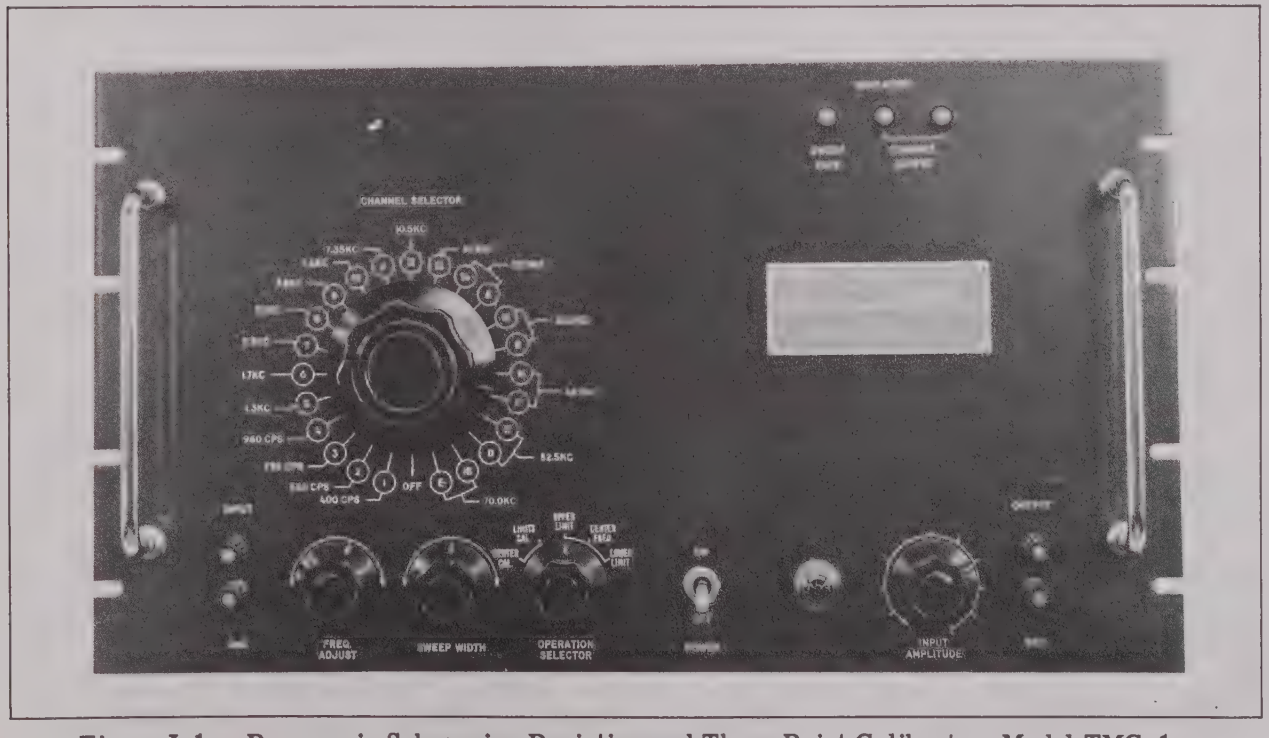

Figure I-1c. Panoramic Subcarrier Deviation and Three Point Calibrator, Model TMC-1a.

involves fewer than the full number of channels since an expanded presentation of just those adjacent channels that are being used can be obtained. For this expanded examination of a portion of the band, a linear-frequency presentation is utilized.

A Panoramic display of the channels permits identification of unwanted effects at a glance thereby affording a quick appraisal of those above tolerable levels. Since such observations can be made with the system in full operation, direct cause and effect correlation can be employed without resorting to special and more difficult instruments and procedures. Routine channel inspection with the Panoramic Instruments will pin point difficulties and allow preventive action to be taken before important system failure is expensively revealed. Another use of the TMI-1b is to set up pre-emphasis of sub-carrier oscillator amplitudes.

With the aid of the Panoramic Telemetering Sub-carrier Deviation and Three Point Calibrator, Model TMC-1a, precise, rapid calibration of individual sub-carrier deviation limits or of individual channel mid-frequencies is possible. Adjustments are facilitated by the fact that both the direction and degree of necessary correction are in full view of the operator at all times. Limit frequency of ±7.5% (or ±15% for the optional bands) of the channel mid-frequency are available for each channel. Limit frequencies closer together than ±7.5% (or, on the optional channels, ±15%) can be obtained simply by employing other crystals. The TMC-1a can be operated so that either limit pips alternate with the subcarrier pip on the TMI-1b screen or a center-frequency pip alternates with the sub-carrier.

The Model TMC-1a can be used by itself as a source of accurate, crystal-derived marker frequencies for the calibration of the sub-carrier discriminators used in the IRIG Standard FM/FM Telemetering System. The upper-limit frequency, center frequency, and lower-limit frequency of each of the 18 IRIG approved FM/FM telemetry sub-carrier channels (as well as the 5 optional channels) are available singly for this calibration. The limit frequencies are ±7.5% of the center frequency for each channel (or, on the optional channels, ±15%). Limit frequencies that are closer together can be obtained by suitably changing the crystals from which the output-signal frequencies are derived.

The TMC-1a crystal frequency accuracy of ±.02% is preserved by deriving the required output-signal frequencies by repeated binary division of the crystal frequencies.

An additional feature is available for the Model TMC-1a which allows automatic calibration of telemetering sub-carrier discriminators and other telemetering equipment. The upper-limit frequency, center frequency, and lower-limit frequency of each of the 18 IRIG Standard FM/FM telemetry subcarrier channels (as well as the 5 optional channels) are made available automatically and in sequential order by the Model TMC-1am. Provision has also been made for automatic synchronous sequential switching of a meter or recorder to the output of the equipment under test such that the meter or recorder is always connected to the channel whose frequency is being provided by the Model TMC-1am.

Provision is made for the use of a G-4 Response Indicator (not supplied) in order to determine the amplitude-versus-frequency response of devices in the frequency region between 350 and 85,000 cps.

I-3. EQUIPMENT SUPPLIED, MODELS TMI-1b, TMP-1b and TMC-1a

a. MODELS TMI-1b and TMP-1b

DESCRIPTION	QUANTITY
Panoramic Telemetering Indicator, Model TMI-1b	1
Panoramic Telemetering Indicator, Power Supply, Model TMP-1b.	1
Constant Voltage Transformer, Panoramic Part No. T3017-1	1
Interconnecting Cable, Power, 12 Wire, TMI-1b to TMP-1b, W3-72	1
Interconnecting Cable, Power 2 Wire, TMI-1b to TMP-1b, W5-72.	1
Interconnecting Cable, Power, 4 Wire, (5 pin connector), TMP-1b to Constant-Voltage Transformer, W34-96.	1
Line cord, AC, 3 Wire, W4-72 with W3033-2 adapter	1
Wrench, Allen No. 4	1*
Wrench, Allen No. 8	1*
Tool, Alignment, Panoramic No. E1010	1*
Spare Fuse, Cartridge, 3a, 250v, Type 3 AG	2**
Spare Fuse, Cartridge, 3/8a, 250v, Slow Blow, Type 3 AG	1**
Screen, CRT, Full Logarithmic Frequency Scale	1#
Screen, CRT, Subcarrier Center Frequency Scale	1#
Filter, CRT, Amber	1##

* Mounted on the right side bracket of the Model TMI-1b

** Mounted on the right side bracket of the Model TMP-1b

\# One of the screens is installed on Model TMI-1b

Installed on Model TMI-1b

b. MODEL TMC-1a

DESCRIPTION	QUANTITY
Panoramic Telemetering Subcarrier Deviation and Three Point Calibrator, Model TMC-1a	1
Constant Voltage Transformer, Panoramic Part No. T3017-2 with Interconnecting Cables	1
Interconnecting Cable, 8 Wire (10 pin connector), TMC-1a to TMI-1b, W79-72	1
Coaxial Cable, RG-62/U, with BNC Plug at each end, W13-72	4
Tool, Alignment, Panoramic No. E1010	1*
Wrench, Allen No. 6	1*
Spare Fuse, Cartridge, 2a, 250v, Type 3 AG	2*
Shorting Plug, No. MS3106A-18-1P, for J408	1**
No. 4 Allen Wrench	1*
No. 10 Allen Wrench	1*
Screwdriver (for Sub-miniature variable resistors)	1*

For TMC-1am the following are also included in addition to items noted under Model TMC-1a.

DESCRIPTION	QUANTITY
Ribbon Connector, 24 Contact Panoramic Part No. P-2139	1

I-4. GENERAL DESCRIPTION

The Panoramic Telemetering Indicator is a scanning heterodyne type of instrument that automatically provides a two-dimensional display of the frequency components of a complex wave, in the region between 350 and 85,000 cycles per second, on the screen of a cathode-ray tube as vertical pips distributed horizontally in order of component frequency. The height of a given pip indicates the relative magnitude of its corresponding frequency component.

Three modes of operation can be selected. In all three modes, the best possible frequency separability, i.e., optimum resolution, is automatically maintained.

a. A logarithmic sweep can be selected in order to obtain a display of the entire spectrum from 350 to 85,000 cycles per second. A complete scan occurs once per second.

b. A linear sweep can be selected. In this mode of operation, front panel controls permit the selection of any center frequency between 400 and 70,000 cycles per second and sweep width from 100 to 20,000 cycles per second. A scan of the selected portion of the overall spectrum occurs once per second. The only conditioning of the equipment that is necessary to obtain this mode of operation is:

1. Setting the SWEEP RANGE SELECTOR knob to LINear.
2. Setting the CENTER FREQUENCY dial to the frequency desired.
3. Setting the SWEEP WIDTH dial to provide proper sweep width.

This automatically presents the desired portion of the telemetry band.

c. The third mode of operation requires the use of the Panoramic Telemetering Sub-carrier Deviation and Three Point calibrator, Model TMC-1a. The Model TMC-1a furnishes accurate, crystal-derived signals for calibrating channels and components in the IRIG approved FM/FM Telemetering system.

The crystal frequency accuracy of ±.02% is preserved by deriving the required output signal frequencies by repeated binary division of the crystal frequencies.

The TMI-1b, TMC-1a combination is used to calibrate the upper and lower limits or the mid-frequency of any one of the 18 IRIG approved FM/FM telemetry sub-carrier channels (as well as the 5 optional channels) or monitor any one of these channels.

The combination is automatically conditioned to display a desired channel with deviation limit marker pips simply by setting three controls as follows:

1. THE TMI-1b SWEEP RANGE SELECTOR to CALibration.
2. The TMC-1a OPERATION SELECTOR to LIMITS CALibration.
3. The TMC-1a CHANNEL SELECTOR to the desired channel.

Under these conditions the appropriate upper and lower limit marker signals are derived from crystal-controlled oscillators in the TMC-1a and presented as pips on the TMI-1b screen sequentially by electronic switching in synchronism with the frequency (i.e., horizontal) sweep of the TMI-1b cathode-ray tube. These pips define the end points on the selected channel. Similarly, on every alternate sweep of the TMI-1b, the sub-carrier oscillator is presented on the TMI-1b screen.

* Mounted on the right side bracket of the Model TMC-1a

** Installed in J408

A complete presentation, consisting of the presentation of first the upper-limit marker pip, then the lower-limit marker pip, and finally the sub-carrier oscillator in the selected channel, occurs once a second. Even though they are on alternate sweeps, the marker and sub-carrier pips are seen simultaneously due to crt screen persistence. In this way close comparison between sub-carrier oscillator and markers is possible by superposition of the sub-carrier pip with either the upper or lower limit marker pip without the deleterious beating effects that would occur if the markers and oscillator were present at the same time. Also, to aid the operator in distinguishing between the markers and the sub-carrier signals, the marker pips are velocity modulated in order to give a dotted presentation to the marker signals.

Using the above outlined technique, the frequency relationship between signals in the channel and the defined end points of the channel can be seen instantly. For example, the voltages that need be applied to the telemetry system sub-carrier oscillators to obtain the proper deviation from the channel center frequency (±7.5% or on the optional channels ±15%) can readily be determined.

Setting the TMC-1a OPERATION SELECTOR to CENTER CALibration results in a crystal derived center-frequency marker pip in place of the two limit pips. Otherwise, the sweep presentation remains unchanged. Thus, the frequency relationship between signals in a channel and the center frequency of the channel can be seen instantly. For example, by adjusting the operating parameters of the sub-carrier oscillator until the oscillator pip is superimposed with the marker pip, the parameters that result in the sub-carrier oscillator operating at its correct mid-frequency can readily be determined.

When the Model TMC-1a is used by itself, it can provide singly, for subcarrier discriminator calibration, the mid-frequency and the upper and lower limit frequency of each of the 18 IRIG approved FM/FM telemetry sub-carrier channels as well as the 5 optional channels. The limit frequencies are ±7.5% of the mid-frequencies or, on the optional channels, ±15%.

An output connector (J107) is provided on the rear chassis apron of Model TMI-1b to allow for the use of a G-4 Response Indicator. The G-4 (not supplied) provides a source of swept signal for use in determining the amplitude versus frequency characteristics of devices in the frequency region between 350 and 85,000 cycles per second. The Model TMI-1b serves as a synchronous selective detector. The exploring swept signal provided by the G-4 is always in register with the "acceptance slot" of the TMI-1b at any portion of the sweep cycle. Direct reading of the amplitude versus frequency characteristic of the device under test is available on the screen of the TMI-1b.

Equipment installation and usage is facilitated by providing duplicate connectors (type BNC), on the rear of each chassis, for the connectors on the front panels. All necessary interconnecting cables are supplied.

The TMI-1b, TMP-1b and TMC-1a are designed for mounting in a standard 19 inch relay rack. Slides permit tilting the units upward either 45 degrees or 90 degrees for access to the under side of the chassis.

Screen observations and photography are facilitated by providing a flat-faced cathode-ray tube (5ADP7), edge lighting for the crt and a camera mounting bezel.

The Model TMC-1am has all the features of Model TMC-1a plus the addition of an AUTOmatic position on the OPERATION SELECTOR switch. In this position the equipment is conditioned to automatically produce signal output sequentially for the upper-limit, center, and lower-limit frequency of each telemetering channel in order, from the lowest to the highest frequency channel. Provision has also been made for automatically monitoring the output of equipment to which these frequencies are supplied. Each frequency remains on for about 6 seconds. The 23 channels are covered automatically in approximately 8 minutes.

Various typical screen presentation are shown in Figure I-2.

Figure I-2a represents the screen presentation that will occur when the TMI-1b is conditioned for the full-coverage logarithmic-frequency mode of operation (SWEEP RANGE SELECTOR set to LOGarithmic). In this case, frequencies are read on the frequency scale at the bottom of the screen. The calibrated screen used in this illustration is calibrated in terms of the center frequencies of the telemetry channels. In this illustration eight telemetry channels are operating, i.e., channels whose center frequencies are 3 kc, 3.9 kc, 5.4 kc, 7.35 kc, 10.5 kc, 14.5 kc, 22 kc and 30 kc.

Figure I-2b represents the screen presentation that will occur for the same signal input as for Figure I-2a but with the TMI-1b conditioned for a linear-frequency mode of operation.

(SWEEP RANGE SELECTOR set to LINear). In this case frequencies are read on the frequency

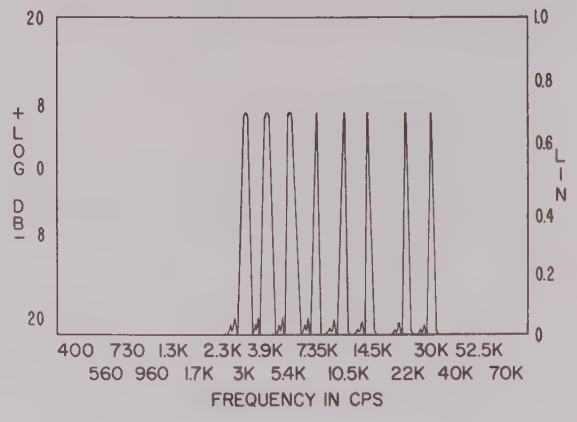

Figure I-2a. TMI-1b Log Frequency Operation.

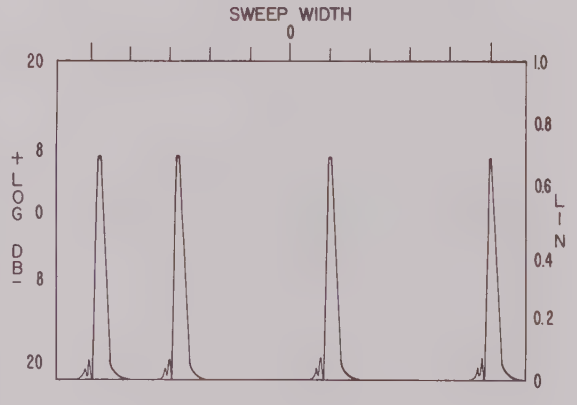

Figure I-2b. TMI-1b Lin Frequency Operation.

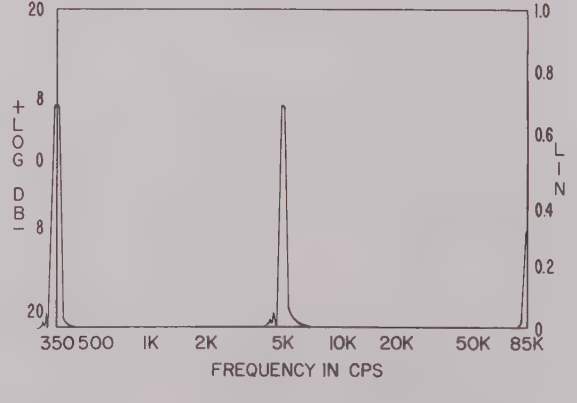

Figure I-2c. TMI-1b Internal Markers. Log Frequency Operation.

(continued overleaf)

Figure I-2. Typical Screen Presentations.

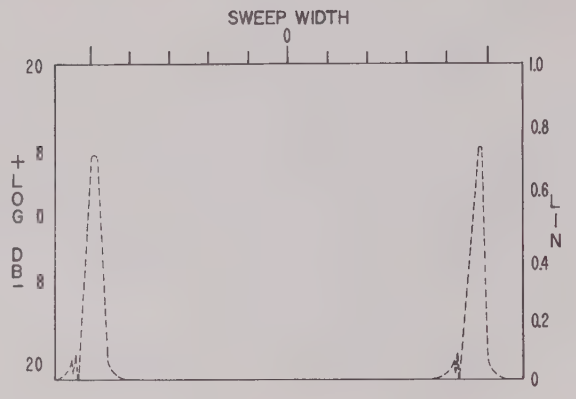

Figure I-2d. TMI-1b, TMC-1a Combination. Upper and Lower Limit Marker Pips (Modulated).

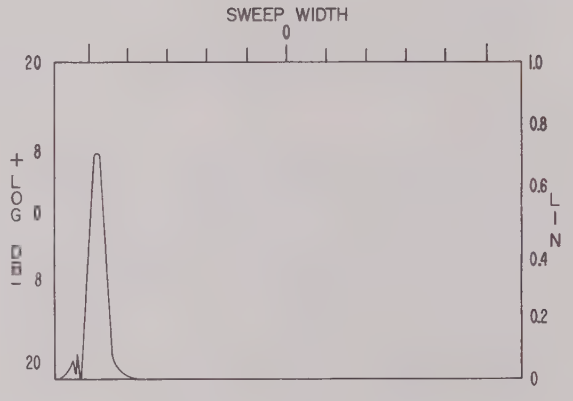

Figure I-2e. TMI-1b, TMC-1a Combination.

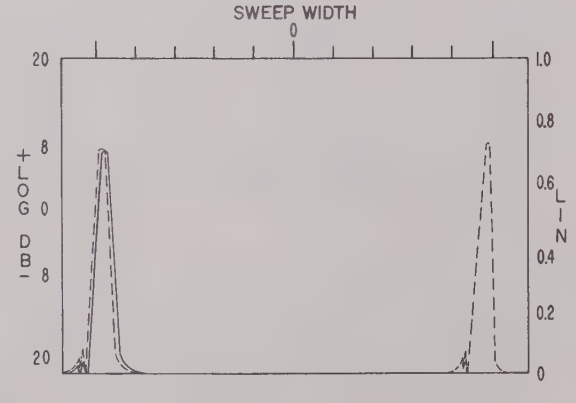

Figure I-2f. TMI-1b, TMC-1a Combination. Superposition of Figures 2d and 2e.

Figure I-2 cont'd. Typical Screen Presentations.

scale at the top of the screen. The sweep width of the presentation is approximately 20 kc with a center frequency of approximately 20 kc. Thus, an expanded linear-frequency presentation of the 4 highest frequency channels shown in Figure I-2a results.

Figure I-2c represents the three internal markers (350 cps, 5 kc, 85 kc) that appear on the TMI-1b screen when the "momentarily on" toggle switch FREQuency MARKERS is held in the ON position. The TMI-1b SWEEP RANGE SELECTOR is set to LOG (for logarithmic frequency mode of operation) in this illustration. Frequencies are read on the frequency scale at the bottom of the screen. The calibrated screen used in this illustration is logarithmically calibrated from 350 cps to 85,000 cps.

Figures I-2d, I-2e, and I-2f represent TMI-1b screen presentations that occur when the TMI-1b is used in conjunction with the TMC-1a OPERATION SELECTOR set to LIMITS CALibration. In this case frequencies are read on the frequency scale at the top of the screen. Figure 2d illustrates the appearance of the upper and lower limit marker pips for a selected channel. The marker pips are velocity modulated giving a dotted presentation. The position of the pips represents the end points of the selected channel. Figure 2e illustrates the appearance of the sub-carrier signal for the selected channel. The sub-carrier pip alternates on the TMI-1b screen with the marker pips. The persistence of the crt screen results in the simultaneous appearance of the sub-carrier and markers. This illustrated in Figure 2f. The positional relationship between the sub-carrier pip and the marker pips depend on the frequency relationship between the sub-carrier frequency and the fixed marker frequencies. When the TMC-1a OPERATION SELECTOR is set to CENTER CALibration, a center frequency marker pip appears instead of end limit pips. Otherwise, the presentation is the same as that for the LIMITS CALibration position.

I-5. ELECTRICAL CHARACTERISTICS, MODELS TMI-1b and TMC-1a

a. MODEL TMI-1b

1. Frequency Range

SWEEP RANGE SELECTOR setting:	Frequency Range
(a) LOGarithmic. . . .	350 cps through 85,000 cps
(b) LINear.	Any selected 100 to 20,000 cps sweep width with a center frequency between 400 and 70,000 cps.
(c) CALibration	Any one of the IRIG Standard FM/FM telemetry sub-carrier channels (when the TMI-1b is used with the Panoramic Model TMC-1a), i.e., ±7.5% of the mid-frequency of each channel, or, in the 5 optional channels, ±15%.

2. Screen Calibrations

Two calibrated screens are supplied. The applicable serial number of the equipment is engraved on each screen. A screen may be used only with the TMI-1b bearing the same serial number.

(a) Amplitude Calibrations

Both calibrated screens have a linear amplitude calibration on the right side of the scale (0 to 1.0 steps of 0.1) and a logarithmic amplitude calibration on the left side of the scale (-20 DB to +20 DB in 4 db steps). A front panel switch, SCALE SELECTOR, is used to select either the LOGarithmic or the LINear amplitude mode of operation.

(b) Frequency calibration

(1) Both calibrated screens have a linear frequency calibration at the top of the scale, each division corresponding to one tenth of the sweep width selected with the SWEEP WIDTH dial.

(2) One of the calibrated screens has a logarithmic frequency calibration at the bottom of the scale calibrated from 350 cps to 85,000 cps. The other screen has a logarithmic frequency calibration at the bottom of the scale marked in terms of the center frequencies of the IRIG approved FM/FM telemetry sub-carrier channels.

3. CENTER FREQ(uency) Dial Calibrations.

The CENTER FREQuency Dial is calibrated from 0 to 70,000 cps. A dot between the "0" and the "1 KC" calibration lines indicates 350 cps.

4. SWEEP WIDTH Dial Calibrations.

The SWEEP WIDTH Dial is calibrated from 100 to 20,000 cps. 100 cps is indicated by a dot. (Calibration accuracy ±25%).

5. Input Amplitude Range.

By appropriate selection of controls, full scale LIN deflection (i.e., SCALE SELECTOR set to LINear), can be obtained for input voltages between 2 millivolts and 10 volts. Full scale LOG deflection (i.e. SCALE SELECTOR set to LOGarithmic can be obtained for input voltages between 20 millivolts and 10 volts.

(a) Full scale LIN deflection for a 10 volt input can be obtained with the following control settings:

INPUT LEVEL, STEP. . . . . 6 DB
SCALE MULTIPLIER X10
INPUT LEVEL,
CONTINUOUS . . . . . Adjusted for full scale deflection (setting near MAXimum)

(b) Full scale LIN deflection for a 2 millivolt input can be obtained with the following control settings:

INPUT LEVEL, STEP . . . . . 60 DB
SCALE MULTIPLIER. X1
INPUT LEVEL,
CONTINUOUS . . . . . Adjusted for full scale deflection (setting near MAXimum)

(c) Full scale LOG deflection for a 10 volt input can be obtained with the following control settings:

INPUT LEVEL, STEP . . . . . 6 DB
SCALE MULTIPLIER. X1
INPUT LEVEL,
CONTINUOUS . . . . . Adjusted for full scale deflection (setting near MAXimum)

(d) Full scale LOG deflection for a 20 millivolt input can be obtained with the following control settings:

INPUT LEVEL, STEP . . . . . 60 DB
SCALE MULTIPLIER. X1
INPUT LEVEL,
CONTINUOUS . . . . . Adjusted for full scale deflection (setting near MAXimum)

6. Relative Voltage Accuracy (for any fixed sweep width.)

±10% throughout the frequency range on the LINear amplitude scale.

±1.5 db throughout the frequency range on the LOGarithmic amplitude scale.

Residual harmonic products (except the second harmonic of 50 kc) are suppressed at least 46 db below the maximum signal permitted on any input range. The baseline rise caused by the second harmonic of 50 kc is suppressed by at least 35 db. Residual cross modulation products of two equal signals of maximum allowable voltage

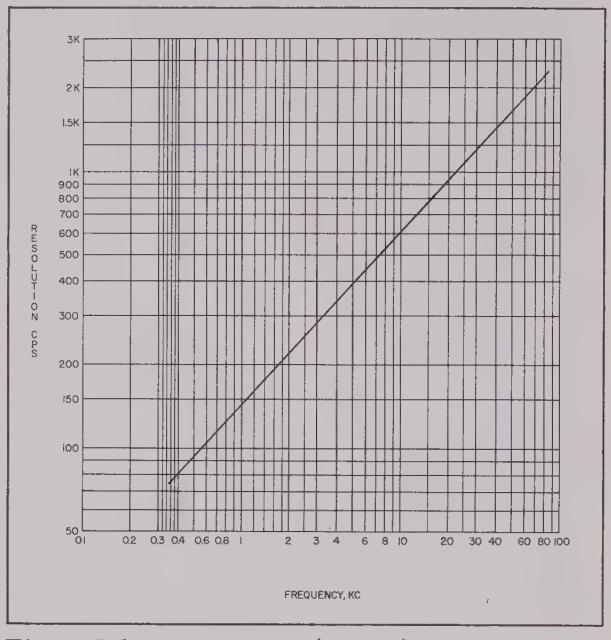

Figure I-3. Resolution (in cps) vs Frequency (in KC). SWEEP RANGE SELECTOR set on LOGarithmic.

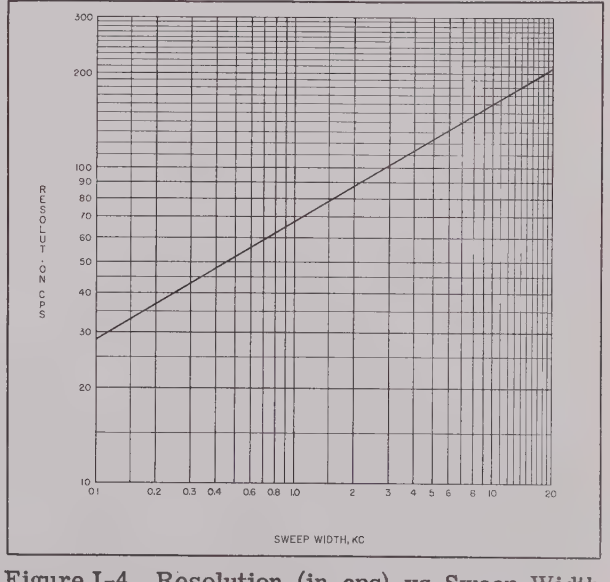

Figure I-4. Resolution (in cps) vs Sweep Width (in KC). SWEEP RANGE SELECTOR set on LINear.

on any input range are suppressed by at least 46 db. Residual hum is suppressed by at least 40 db.

7. Resolution

Resolution is defined as the frequency separation of two signals of equal amplitude, the deflections of which intersect .5 down from their peak amplitudes. Figure I-3 is a resolution curve with the SWEEP RANGE SELECTOR set on LOGarithmic Figure I-4 is a resolution curve with the SWEEP RANGE SELECTOR set on LINear.

8. Measurement of Unequal Amplitude Signals.

Figure I-5 indicates minimum frequency separation required to measure signals of unequal amplitude.

9. Scanning Rate

The scanning rate when the SWEEP RANGE SELECTOR is on LOGarithmic or LINear is once per second. When the SWEEP RANGE SELECTOR is on CALibration and the Model TMC-1a is being used in conjunction with the Model TMI-1b, the scanning rate is two per second.

10. Input Impedance

The input impedance is 50 K ohms.

11. Frequency Markers

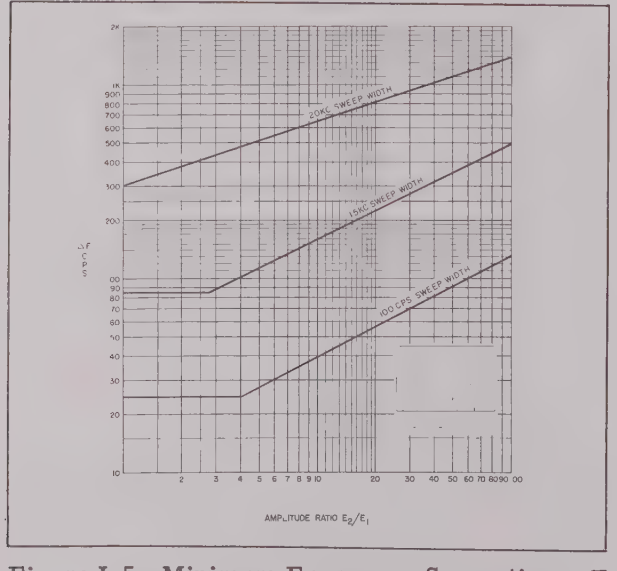

Figure I-5. Minimum Frequency Separation, ΔF (in cps), Required to Measure Amplitude Ratios E_2/E_1. SWEEP RANGE SELECTOR set on LINear.

Internal frequency markers of 350, 5,000, and 85,000 cps with their respective harmonics can be turned on simultaneously.

12. Power Requirements

The power required at the input to the constant-voltage transformer, Pan Part T3017-1, is 225 watts at 115 volts, 60 cps. The equipment will operate satisfactorily over an input voltage range of 95 to 125 volts.

b. MODEL TMC-1a

1. Marker Frequencies

(a) All 18 IRIG Standard FM/FM telemetering channel mid-frequencies.

(b) IRIG limit frequencies of nominally plus and minus 7.5% of each mid-frequency.

(c) Limit frequencies of plus and minus 15% of the mid-frequency of the 5 highest frequency (optional) channels.

NOTE

(1) With the OPERATION SELECTOR set on LIMITS CALibration, only the limit frequencies of the channel to which the CHANNEL SELECTOR is set are available at the output. They are available at the output of the TMC-1a in the following sequence. For the first 1/4 second, the upper-limit frequency is available. For the next 1/4 second the lower limit frequency is available. For the next 1/2 second, the equipment is conditioned to pass input signals. This completes one cycle of operation.

(2) With the OPERATION SELECTOR set to CENTER CALibration, only the center frequency of the channel to which the CHANNEL SELECTOR is set is available at the output. A cycle of operation consists of a half second in which the center frequency is available at the output, followed by a half second during which the equipment is conditioned to pass input signals.

(3) The upper-limit frequency, center frequency, and lower-frequency for the particular channel to which the CHANNEL SELECTOR is set can be obtained at the output by setting the OPERATION SELECTOR on UPPER LIMIT, CENTER FREQuency, or LOWER LIMIT respectively.

The available calibrating frequencies are therefore as follows:

Channel	Center Freq. in cps	Lower Limit in cps	Upper Limit in cps
1	400	370	430
2	560	518	602
3	730	675	785
4	960	888	1,032
5	1,300	1,202	1,398
6	1,700	1,572	1,828
7	2,300	2,127	2,473
8	3,000	2,775	3,225
9	3,900	3,607	4,193
10	5,400	4,995	5,805
11	7,350	6,799	7,901
12	10,500	9,712	11,288
13	14,500	13,412	15,588
14	22,000	20,350	23,650
15	30,000	27,750	32,250
16	40,000	37,000	43,000
17	52,500	48,560	56,440
18	70,000	64,750	75,250
A	22,000	18,700	25,300
B	30,000	25,500	34,500
C	40,000	34,000	46,000
D	52,500	44,620	60,380
E	70,000	59,500	80,500

(4) With the OPERATION SELECTOR set to AUTOmatic the output frequency of the TMC-1am becomes controlled by an internal motor. The upper-limit, center, and lower-limit frequency of each channel is produced in sequential order. A cycle of operation covering all channels, consists of about 8 minutes, each output frequency being on for about 6 seconds as follows: Channel 1, upper-limit frequency, center frequency lower-limit frequency; Channel 2, upper-limit frequency, center frequency, lower-limit frequency;.....; Channel E, upper limit frequency, center frequency, lower-limit frequency. There is about 2 seconds of switching time between channels. Provision has also been made for automatic monitoring of the output of the equipment to which the Model TMC-1am is connected.

2. Marker Wave Shape - approximately square wave.

3. Marker Accuracy - + .02%

4. Marker Output Amplitude

(a) When OPERATION SELECTOR is on CENTER CALibration or LIMITS CALibration, the amplitude of the fundamental is approximately equal to the output level of a signal input of 10 millivolts.

(b) When OPERATION SELECTOR is on UPPER LIMIT, CENTER FREQuency, or LOWER LIMIT, the amplitude of the fundamental is at least 0.5 volt.

5. Signal Input - Any signal input between 10 millivolts and 10 volts can be adjusted for a presentation amplitude on the TMI-1b screen that is equal to that of the marker pip.

6. Input Impedance - 50 K ohms.

7. Output Impedance - Low, (Cathode follower).

8. Spurious signals are suppressed 46 db below the peaks of the markers observed on the screen of the Model TMI-1b when monitoring a single channel.

9. Power requirements - The power required at the input to the constant-voltage transformer, Pan Part No. T3017-2, is 150 watts at 115 volts, 60 cps. The equipment will operate satisfactorily over input voltage range of 95 to 125 volts.

I-6. PHYSICAL CHARACTERISTICS

a. WEIGHTS

Description	Weight
Model TMI-1b	35 lbs
Model TMP-1b	33 lbs
Model TMC-1a	44 lbs
Slides for TMI-1b	6 lbs
Slides for TMP-1b	.4 lbs
Slides for TMC-1a	6 lbs
Cables for TMI-1b, TMP-1b and TMC-1a	6 lbs
Constant-Voltage Transformer, Panoramic Part No. T3017-1	22-1/2 lbs
Constant-Voltage Transformer, Panoramic Part No. T3017-2	23-1/2 lbs

b. DIMENSIONS

Description	Dimensions
Model TMI-1b front panel	$10\frac{1}{2}$ in. h x 19 in. w x 3/16 in.t
Projection of handles from TMI-1b front panel	1-3/4 in.
Depth of TMI-1b chassis	16-3/4 in.*
Model TMP-1b front panel	8-3/4 in. h x 19 in. w x 3/16 in.t
Projection of handles from TMP-1b front panel	1-3/4 in.
Depth of TMP-1b chassis	12 in.
Model TMC-1a front panel	$10\frac{1}{2}$ in. h x 19 in w x 3/16 in.t
Projection of handles from TMC-1a front panel	1-3/4 in.
Depth of TMC-1a chassis	17-1/16 in. **
Depth of Model TMC-1am chassis	17-1/4 in. when P420 is used
Constant-Voltage Transformer, Pan Part No. T3017-1	11-5/8 in. lg x 6-15/16 in. w x 5-5/8 in. h (mounting centers 3-1/4 in. x 6-1/8 in.)
Constant-Voltage Transformer, Pan Part No. T3017-2	11-3/16 in. lg x 4-3/16 in w x 4-3/8 in. h (mounting centers 2-3/8 in. x 10-7/16 in.)
Interconnecting cable, power, 12 wire, W3-72, with two plugs: No. MS3106A-28-18S and No. MS3106A-28-18P	6 ft. lg.
Interconnecting cable, power, 2 wire, W5-72 with two plugs: No. MS3106A-22-11S and No. MS3106A-22-11P	6 ft. lg.
Interconnecting cable, power, 4 wire (5 pin connectors), W34-96 with two plugs: No. MS3106A-14S-5S and No. MS3106A-14S-5P	8 ft. lg.
Line cord, AC, 3 wire, W4-72, with two plugs: Hubbell No. 7506 and Hubbell No.7057 and W-3033-2 adapter	6 ft. lg.
Interconnecting cable, 8 wires (10 pin connector), W79-72, with two plugs: No. MS3106A-18-1S and No. MS3106A-18-1P	6 ft. lg.
Coaxial Cable, RG-62/U, with two BNC plugs, (UG-260/U), W13-72	6 ft. lg.
Cables of Constant-Voltage Transformer Panoramic Part No. T3017-2 One cable has a Hubbell No. 7484 plug and the other a Hebbell No. 7057 plug***	each 6 ft. lg.

I-7. TUBE COMPLEMENT

a. MODEL TMI-1b

Circuit Reference Symbol	Tube Type	Function
V101	12AY7	A: Phase splitter B: Input cathode follower
V102	12C56	Oscillator buffer
V103	5879	Balanced modulator

* Including projection of leads to crt
** Including projection of fuse holders
*** Cables and plugs are an integral part of constant voltage transformer Pan Part No. T3017-2

Circuit Reference Symbol	Tube Type	Function
V104	5879	Balanced modulator
V105	6BH6	First i-f amplifier
V106	6AU6	Second i-f amplifier
V107	6AU6	Third i-f amplifier
V108	6T8	A: Detector B: Vertical amplifier
V109	5814	A: Vertical output B: Not used
V110	6021	A: Reactance tube B: Oscillator
V111	12AT7	A: Oscillator-output cathode follower B: Oscillator Limiter
V112	GL-6201	Selectivity-control tube No. 1
V113	GL-6201	Selectivity-control tube No. 2
V114	5ADP7	Visual indicator (cathode-ray tube)
V115	5751	A: 5-kc marker generator B: 350 cycle marker generator
V116	5751	A: 85-kc marker generator B: Not used
V117	12AY7	A: Cathode follower (Lin sweep) B: Not used
V118	2D21	Log wave generator
V119	5814	A: Blocking-tube oscillator B: BTO-output cathode follower
V120	5814	Horizontal-output amplifier

b. MODEL TMP-1b

Circuit Reference Symbol	Tube Type	Function
V901	5R4GY	Low-voltage rectifier
V902	6AS7G	Series regulator
V903	5751	Regulator-control tube
V904	5651	Regulator-reference tube
V905	5651	Negative-voltage regulating tube

c. MODEL TMC-1a

Circuit Reference Symbol	Tube Type	Function
V401	5964	Frequency Divider
V402	5964	Frequency Divider

Circuit Reference Symbol	Tube Type	Function
V403	5964	Frequency Divider
V404	5844	Frequency Divider
V405	5844	Frequency Divider
V406	5844	Frequency Divider
V407	5844	Frequency Divider
V408	5844	Frequency Divider
V409	5844	Frequency Divider
V410	12AT7	A: Upper-Limit-Center-Frequency Crystal Oscillator B: Crystal-Oscillator Cathode Follower Output
V411	12AT7	A: Lower-Limit Crystal Oscillator B: Crystal-Oscillator Cathode Follower Output
V412	5814	A: Blocking-Tube Oscillator B: Velocity-Modulator Cathode Follower
V413	5844	Frequency Divider (Gate Control)
V414	21AT7	Limiter-Amplifier
V415	12AT7	A: Swept Oscillator B: Reactance Tube
V416	5R4GY	Rectifier
V417	OA2	150-V Voltage Regulator
V418	OA3	75-V Voltage Regulator
V419	12AT7	A: Sync-Output Cathode Follower B: Composite-Signal Cathode Follower
V420	5844	Frequency Divider (Gate Control)
V421	12AT7	A: Marker-Gate Control B: Marker Amplifier and Gate
V422	12AT7	A: Signal Amplifier and Gate B: Signal-Gate Control
V423	12AT7	A: Swept-Oscillator Cathode Follower Output B: Swept-Oscillator Amplifier
V424	6AL5	Divider-Chain Dual-Diode Input
V425	12AT7	A: Gate for V411 B: Gate for V410

d. TMC-1a CRYSTALS

Circuit Reference Symbol	Channel	Deviation	Crystal Frequency (kc)
Y401	1	+ 7.5%	220.160
Y426		0.0%	204.800
Y451		- 7.5%	189.400

Circuit Reference Symbol	Channel	Deviation	Crystal Frequency (kc)
Y402	2	+ 7.5%	308.224
Y427		0.0%	286.720
Y452		- 7.5%	265.216

Circuit Reference Symbol	Channel	Deviation	Crystal Frequency (kc)
Y403	3	+ 7.5%	401.920
Y428		0.0%	373.760
Y453		- 7.5%	345.600
Y404	4	+ 7.5%	264.192
Y429		0.0%	245.760
Y454		- 7.5%	227.328
Y405	5	+ 7.5%	357.888
Y430		0.0%	332.800
Y455		- 7.5%	307.712
Y406	6	+ 7.5%	233.984
Y431		0.0%	217.600
Y456		- 7.5%	201.216
Y407	7	+ 7.5%	316.544
Y432		0.0%	294.400
Y457		- 7.5%	272.256
Y408	8	+ 7.5%	412.800
Y433		0.0%	384.000
Y458		- 7.5%	355.200
Y409	9	+ 7.5%	268.352
Y434		0.0%	249.600
Y459		- 7.5%	230.848
Y410	10	+ 7.5%	371.520
Y435		0.0%	345.600
Y460		- 7.5%	319.680
Y411	11	+ 7.5%	252.832
Y436		0.0%	235.200
Y461		- 7.5%	217.568
Y412	12	+ 7.5%	361.216
Y437		0.0%	336.000
Y462		- 7.5%	310.784
Y413	13	+ 7.5%	249.408
Y438		0.0%	232.000
Y463		- 7.5%	214.592
Y414	14	+ 7.5%	378.400
Y439		0.0%	352.000
Y464		- 7.5%	325.600
Y415	A	+15.0%	404.800
Y465		-15.0%	299.200
Y416	15	+ 7.5%	258.000
Y440		0.0%	240.000
Y466		- 7.5%	222.000
Y417	B	+15.0%	276.000
Y467		-15.0%	204.000
Y418	16	+ 7.5%	344.000
Y441		0.0%	320.000
Y468		- 7.5%	296.000
Y419	C	+15.0%	368.000
Y469		-15.0%	272.000
Y420	17	+ 7.5%	225.760
Y442		0.0%	210.000
Y470		- 7.5%	194.240
Y421	D	+15.0%	241.520
		0.0%	
Y471		-15.0%	178.480
Y422	18	+ 7.5%	301.000
Y443		0.0%	280.000
Y472		- 7.5%	259.000
Y423	E	+15.0%	322.000
Y473		-15.0%	238.000

I-8. FRONT PANEL CONTROLS

a. PANORAMIC TELEMETERING INDICATOR, MODEL TMI-1b.

1. Operating Controls

(a) COARSE BALANCE

This is a coarse control used, in conjunction with FINE BALANCE (see (b) below), to suppress deflections caused by the swept local oscillator as it approaches the intermediate frequency. Both COARSE BALANCE and FINE BALANCE have a differential effect on the gain of the balanced modulators.

(b) FINE BALANCE

This is a vernier control on COARSE BALANCE and is used to improve the preliminary balance obtained with COARSE BALANCE. (See (a) above).

(c) PHASE BALANCE

The PHASE BALANCE control is used to adjust the phase relation of the balanced modulator

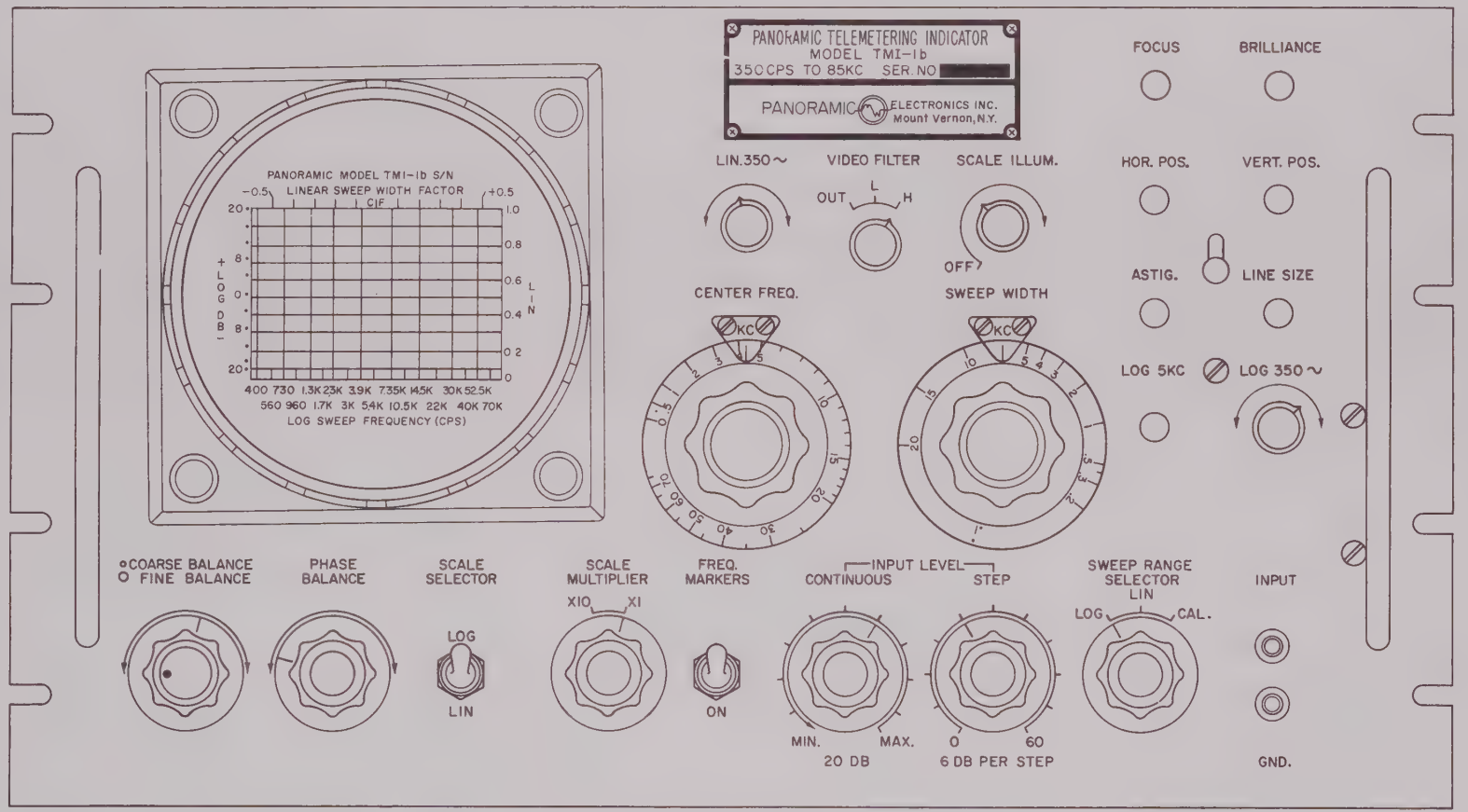

Figure I-6. TMI-1b Front Panel.

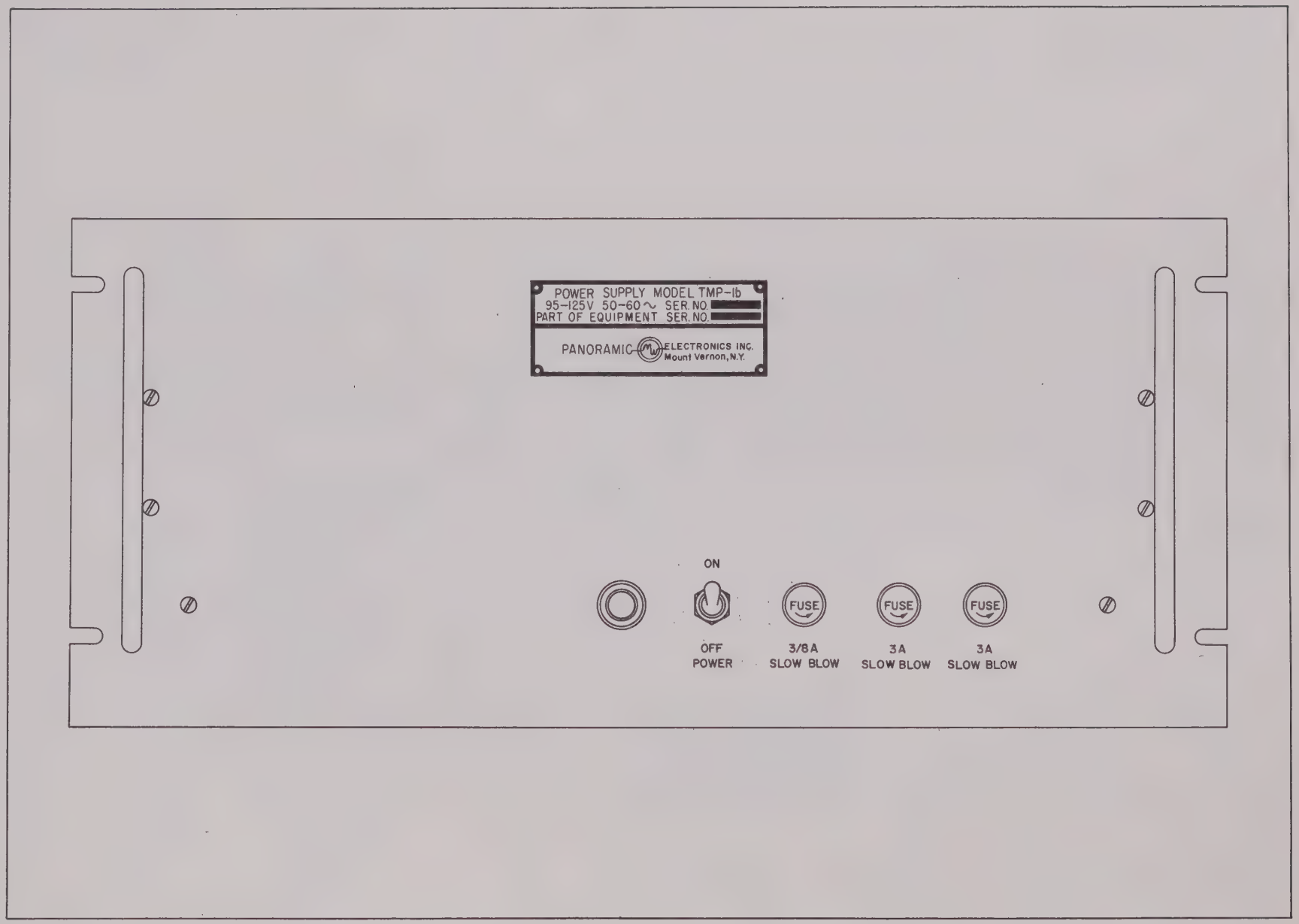

Figure I-7. TMP-1b Front Panel.

tubes so as to suppress deflections that would result from improper phase relationships of the local swept-oscillator signals or the balanced-modulator circuitry.

(d) SCALE SELECTOR (LIN - LOG)

This two-position switch is used to select either a linear voltage amplitude scale or a logarithmic voltage amplitude scale. The linear scale markings appear on the right side of the screen and allow simultaneous measurement of voltage ratios as high as 10:1. The logarithmic voltage scale markings appear on the left side of the screen and allow simultaneous measurement of voltage ratios as high as 100:1 (40 db).

(e) SCALE MULTIPLIER

For any given setting of the INPUT LEVEL Controls, this switch provides 10 times additional attenuation when switched from X1 to X10. This control is also used to attenuate the frequency markers. (See (f) below.) The X10 position should only be used when the SCALE SELECTOR is on LINear. When the SCALE SELECTOR is set to LOGarithmic the SCALE MULTIPLIER must be set on X1.

(f) FREQuency MARKERS

This "momentarily on" toggle switch turns on, when held in the "ON" position, the 350, 5 K and 85 K cycles per second markers and their respective harmonics simultaneously. The amplitude of these markers is controlled by the SCALE MULTIPLIER. (See (e) above.)

(g) INPUT LEVEL

(1) STEP Control.

A rotation of this control counterclockwise gives a maximum of 60-db attenuation of the input signal in 6-db steps.

(2) CONTINUOUS Control

A full counterclockwise rotation of this control gives a 20-db attenuation of the input signal.

(h) SWEEP RANGE SELECTOR (LOGarithmic - LINear - CALibration).

This switch provides three modes of operation.

(1) LOGarithmic

This position is used to provide a logarithmic sweep in order to obtain a display of the entire spectrum from 350 to 85,000 cycles per second.

(2) LINear

This position is used to provide a linear sweep to examine any 100 to 20,000 cycles per second portion of the spectrum from 350 to 80,000 cycles per second. The center frequency of the portion selected is governed by the setting of the CENTER FREQuency control (See (1) below) while the bandwidth is governed by the setting of the SWEEP WIDTH Control (see (m) below).

(3) CALibration (This position is used only when the TMI-1b is used with the TMC-1a).

This position is used to accurately calibrate the upper and lower limits or the sub-carrier itself of any one of the 18 IRIG approved FM/FM telemetry sub-carrier channels. The signals in the selected sub-carrier channel alternate with the appropriate upper and lower limit markers or the mid-frequency marker on the screen of the Model TMI-1b. Sub-carrier channels are selected and markers are provided in the Model TMC-1a.

(i) SCALE ILLUMination.

This control is used to adjust the intensity of edge lighting of the screen. It has an OFF position.

(j) VIDEO FILTER (operative only in the LINear and CALibration positions of the SWEEP RANGE SELECTOR).

This switch is used to introduce a filter at the output of the detector to reduce spurious beats that result when two signals are close in frequency. Two degrees of filtering are available; high (marked H), and low (marked L). In addition the switch has an OUT position that removes the video filter from the circuit. For normal operation the switch is kept on the OUT position. H and L are used when two signals appear on the screen so close in frequency as to cause beats that are normally not sufficiently filtered. Since the video filter integrates the pulse as seen on the screen, it should not be used when amplitude measurements are being made. Note also that the video filter has an adverse effect on resolution.

(k) LINear 350~ (used only when the SWEEP RANGE SELECTOR is on LINear).

This control is used to set the calibration of the low frequency end of the CENTER FREQuency Dial.

(l) CENTER FREQuency

This control is used in the LINear setting of the SWEEP RANGE SELECTOR. It provides a continuously variable selection of the frequency that will appear under the 0 (Center) marker on the screen. The dial associated with this control is calibrated from 0 to 70,000 cycles per second.

(m) SWEEP WIDTH

This control is used in the LINear setting of the SWEEP RANGE SELECTOR. It is used to provide any sweep width from 100 to 20,000 cycles per second. The sweep width is indicated on the associated calibrated dial.

(n) LOGarithmic 350 ~ (used only when the SWEEP RANGE SELECTOR is on LOGarithmic).

This control is used to bring the 350 cycle marker into alignment with the 350 cycle screen calibration.

2. Screwdriver-Adjust Controls

(a) FOCUS

This control adjusts the sharpness of the trace.

(b) BRILLIANCE

This control is used to adjust the intensity of the trace. Clockwise rotation increases the intensity.

(c) HORizontal POSition.

This control is used to adjust the horizontal position of the trace on the screen.

(d) VERTical POSition

This control is used to adjust the vertical position of the trace on the screen.

(e) ASTIGmatism

This control is used to provide uniform focus throughout the trace.

(f) LINE SIZE

This control is used to obtain the proper line size.

(g) LOGarithmic 5 KC (used only when the SWEEP RANGE SELECTOR is on LOGarithmic).

This control is used to bring the 5 KC marker into alignment with the 5 KC screen calibration.

b. PANORAMIC TELEMETERING INDICATOR POWER SUPPLY, MODEL TMP-1b.

1. POWER (ON - OFF)

This switch is used to turn the power line input to Model TMP-1b on or off.

c. PANORAMIC TELEMETERING SUBCARRIER DEVIATION and THREE POINT CALIBRATOR, MODEL TMC-1a.

1. CHANNEL SELECTOR

This control is used to select the desired telemetering channel.

(a) When the OPERATION SELECTOR is on LIMITS CALibration or CENTER CALibration the CHANNEL SELECTOR:

(1) Selects the appropriate pair of crystal derived markers to define the end points of the particular sub-carrier channel, or selects a crystal derived marker to define the center of the particular channel depending on whether the OPERATION SELECTOR is set to LIMITS CALibration or CENTER CALibration.

(2) Selects the appropriate sweep width and center frequency of the swept oscillator of the TMC-1a so that the selected channel is suitably displayed on the TMI-1b screen.

(3) Adjusts the TMI-1b to provide optimum resolution.

(b) When the OPERATION SELECTOR is on other than LIMITS CALibration, or CENTER CALibration the CHANNEL SELECTOR is used to select the desired marker frequencies for discriminator alignment and other possible uses.

2. FREQuency ADJUST

When the OPERATION SELECTOR is on LIMITS CALibration, this control is used as a vernier to adjust the center frequency of the TMC-1a swept oscillator so that the marker pips are symmetrical about the center of the TMI-1b screen. When the OPERATION SELECTOR is on CENTER CALibration this control is used as a vernier to adjust the center frequency of the TMC-1a swept oscillator so that the mid-frequency marker pip is at the center of the TMI-1b screen. The same setting of FREQuency ADJUST is appropriate for both CENTER and LIMITS CALibration.

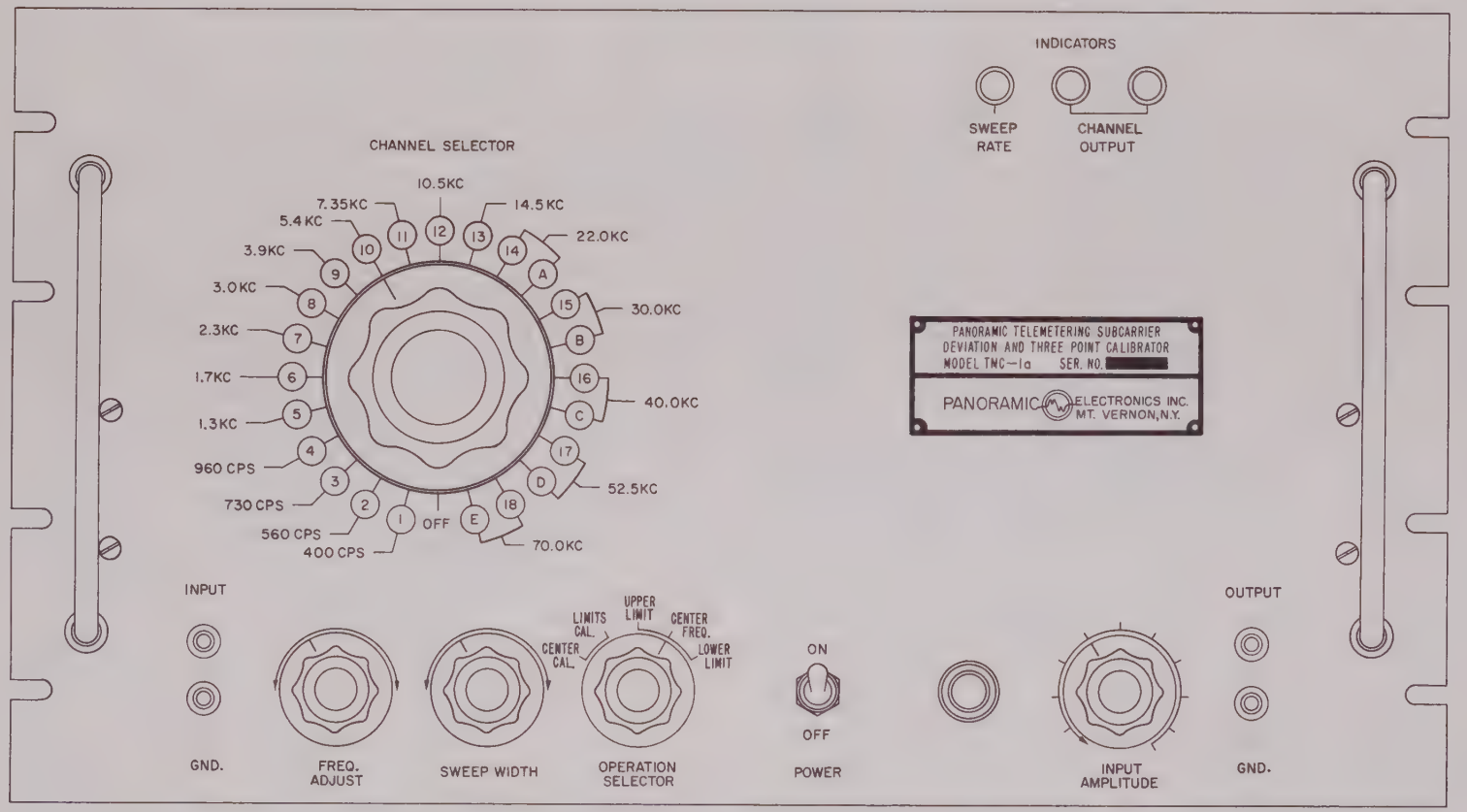

Figure I-8. TMC-1a Front Panel.

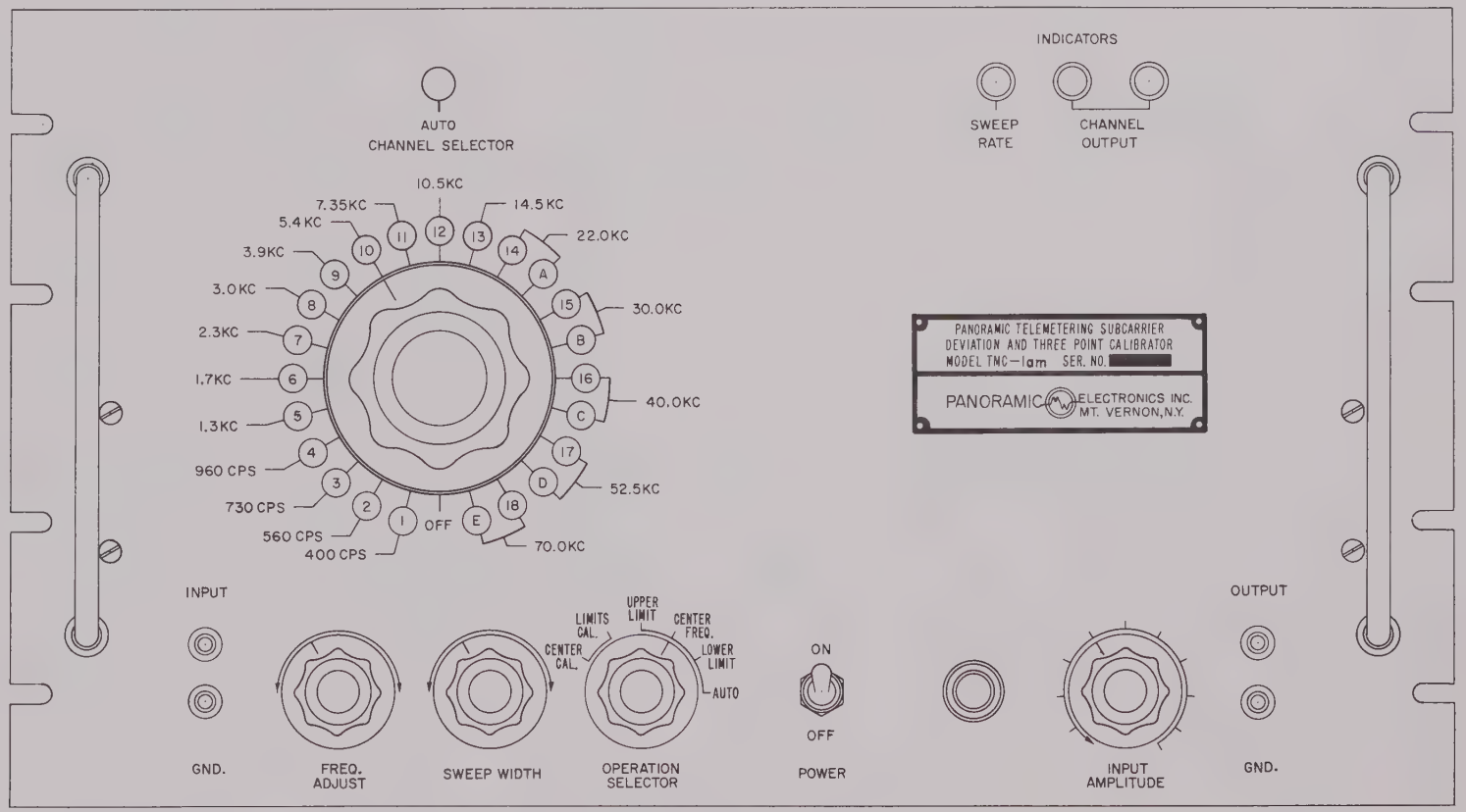

Figure I-9. TMC-1am Front Panel.

3. SWEEP WIDTH

When the OPERATION SELECTOR is on LIMITS CALibration, this control is used as a vernier to adjust the sweep width of the TMC-1a swept oscillator so that the distance between the marker pips is suitable on the TMI-1b screen. Once a suitable position has been found it is not necessary to change the control setting when switching to CENTER CALibration.

4. OPERATION SELECTOR

This switch is used to condition the Model TMC-1a to operate either as a channel calibrator (switch set on LIMITS CALibration or CENTER CALibration) in conjunction with the Model TMI-1b or as a three point calibrator for such purposes as discriminator alignment (switch position UPPER LIMIT, CENTER FREQuency, and LOWER LIMIT).

(a) The operation of the Model TMC-1a when the switch is on LIMITS CALibration or CENTER CALibration is described in paragraph c,1(a) above.

(b) When the switch is on positions other than CALibration, the Model TMC-1a supplies, individually, marker frequencies for the intended use. The desired triad (upper limit, lower limit, and center frequency) is selected with the CHANNEL SELECTOR. The OPERATION SELECTOR is used to provide, within the triad, either the upper-limit frequency or the center frequency or the lower-limit frequency required for the alignment (switch position UPPER LIMIT, CENTER FREQuency, and LOWER LIMIT respectively).

(c) When the OPERATION SELECTOR is set on AUTOmatic, the Model TMC-1am supplies marker frequencies, one at a time in sequential order for all channels (upper-limit, center, and lower-limit frequency). An additional indicator lamp marked AUTOmatic serves to indicate when the motor is operating.

5. POWER (ON - OFF)

This switch is used to turn the power line input to the Model TMC-1a on or off.

6. INPUT AMPLITUDE

When the OPERATION SELECTOR is on LIMITS CALibration, or CENTER CALibration, this control is used to adjust the amplitude of the input signal to the TMC-1a thereby controlling the amplitude of the corresponding screen presentation on the TMI-1b.

CHAPTER II
INSTALLATION

II-1. UNPACKING

Be careful in unpacking and handling the equipment to avoid damage or undue exposure to the elements. Check the contents against the packing slip to avoid loss of parts in the packing material. Examine the equipment to determine whether or not any damage had occurred in shipping.

Report any losses or damage immediately.

The equipment is shipped with all its tubes and crystals already installed. See that all tubes, crystals, and plug-in units are well seated in their sockets.

II-2. MOUNTING

The equipment is designed for mounting in a standard relay rack. Slots on the sides of the front panels are provided for mounting the equipment to the front of the rack. Suitable brackets must be used to mount the equipment slides to the sides of the rack. Locate the constant voltage transformer for effective ventilation. See Figures II-1, II-2, II-3 and II-4.

II-3. INTERCONNECTING PROCEDURE

a. TMI-1b to TMP-1b.

Interconnect the various units in accordance with Table II-1. See also Figure II-1.

b. TMC-1a to TMI-1b

1. Interconnect the various units in accordance with Table II-2. See Also Figure II-1.

NOTE

When the TMC-1a is used by itself as a source of signals for discriminator calibration, only steps 1, 2, and 3 of the table need be followed. In addition it will be necessary to set the TMI-1b SWEEP RANGE SELECTOR to CALibration. It is not necessary, in this case, to turn on the TMI-1b. If the TMC-1a is used for discriminator calibration in a location remote from the TMI-1b, step 1 of Table II-2 (and the necessity of setting the TMI-1b SWEEP RANGE SELECTOR to CALibration can be replaced by suitably interconnecting pins "A" and "B" of receptacle J408 of the TMC-1a. This is best done by using the supplied mating plug that has pins "A" and "B" interconnected.

WARNING

THE TMI-1b, TMC-1a COMBINATION IS SUPPLIED IN MATCHED PAIRS. IT IS NOT POSSIBLE TO USE A TMI-1b FROM ONE PAIR WITH A

TABLE II-1. INTERCONNECTING PROCEDURE, MODELS TMI-1b and TMP-1b

Step Number	Cable No.	Cable Description	Connections	
			From	To
1	W3-72	12 wire power cable	J110 of TMI-1b	J910 of TMP-1b
2	W5-72	2 wire power cable	J109 of TMI-1b	J909 of TMP-1b
3	W34-96	4 wire power cable (with 5 pin connectors)	J903 of TMP-1b	J905 of Constant voltage transformer Pan Part No. T3017-1
4	W4-72	3 wire ac line cord SINGER NO 04-556161-066	J902 of TMP-1b	Source of 95 - 125 volt, 60 cps, single phase power

TMC-1a FROM ANOTHER PAIR WITHOUT CONSIDERABLE REALIGNMENT. BOTH UNITS, OF A PAIR HAVE THE SAME TYPE NUMBER ON THE PATENT LABEL LOCATED ON THE REAR APRON OF THE EQUIPMENT CHASSIS.

2. Set the TMI-1b SWEEP RANGE SELECTOR to CALibration. When TMC-1am is used to switch automatically from channel to channel, a meter or recorder is wired to the output of an equipment being tested. The meter or recorder may be connected between pin 24 and ground. The output of each channel is then connected between its corresponding marker on the connector and ground. If the meter is in a balanced circuit, relays may be used to switch the meter. The relays are then wired to P420.

3. The TMI-1b, TMP-1b, TMC-1a combination is now ready for use. See, however, the note in paragraph II-3, b above concerning the use of the TMC-1a by itself as a source of signals for discriminator calibration.

II-4. INSTALLATION ADJUSTMENTS AND CHECKS

NOTE

If the adjustment given in this section fail to give the indicated results, Chapter V - Service and Maintenance should be referred to for appropriate maintenance action.

a. TMI-1b

1. Set the following TMI-1b front-panel controls as listed.

SWEEP RANGE SELECTOR . . . . . LOGarithmic
SCALE SELECTOR . . . . . LOGarithmic
SCALE MULTIPLIER X10
INPUT LEVEL, CONTINUOUS . . . MAXimum
VIDEO FILTER . . . . . OUT

TABLE II-2. INTERCONNECTING PROCEDURE, MODELS TMC-1a AND TMI-1b.

Step Number	Cable No.	Cable Description	Connections From	Connections To
1	W79-72	8 wire cable (with 10 pin connectors)	J408 of TMC-1a	J108 of TMI-1b
2	Integral with Transformer	Constant voltage transformer cable with female plug	Constant voltage transformer Pan Part No. T3017-2	J401 of TMC-1a
3	Integral with Transformer	Constant voltage transformer cable with male plug	Constant voltage transformer Pan Part No. T3017-2	Source of 95-125 volts, 60 cps, single phase power
4	W13-72	Coaxial Cable, RG-62/U, with two BNC plugs	J406 (marked "VEL MOD OUTPUT") of TMC-1a	J105 (marked "VEL MOD TO J406") of TMI-1b
5	W13-72	Coaxial Cable, RG-62/U, with two BNC plugs	J405 (marked "Osc OUTPUT") on oscillator Sub-chassis of TMC-1a	J105 (marked "CAL OSC INPUT TO J405") of TMI-1b
6	W13-72	Coaxial Cable, RG-62/U, with two BNC plugs	J404 (marked "OUTPUT") of TMC-1a	J104 (marked "CAL OUTPUT TO J404") of TMI-1b
7	W13-72	Coaxial Cable RG-62/U, with two BNC plugs	J403 (marked "INPUT") of TMC-1a	J103 (marked "CAL INPUT TO J403") of TMI-1b

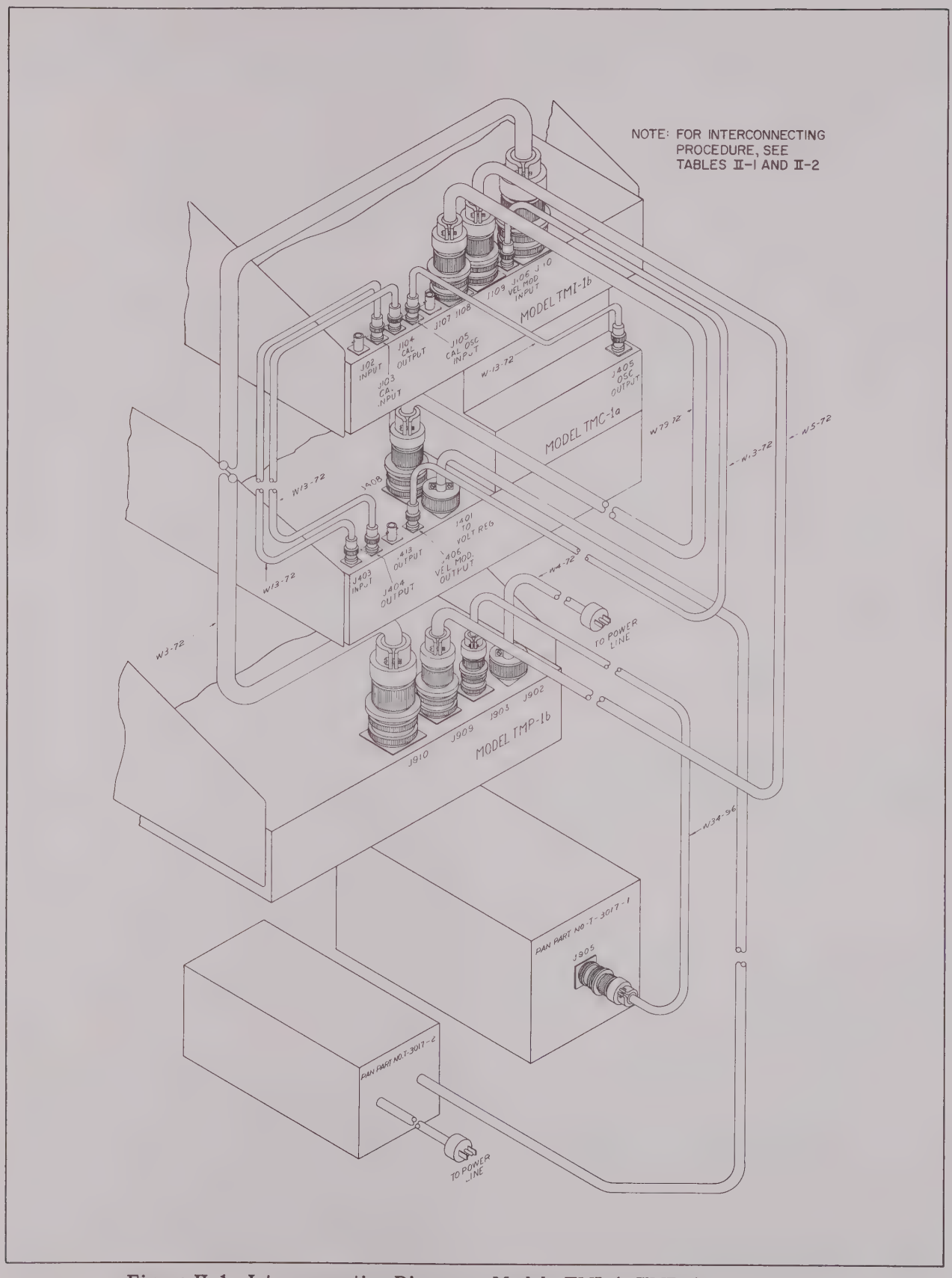

Figure II-1. Interconnecting Diagram. Models TMI-1, TMP-1, and TMC-1.

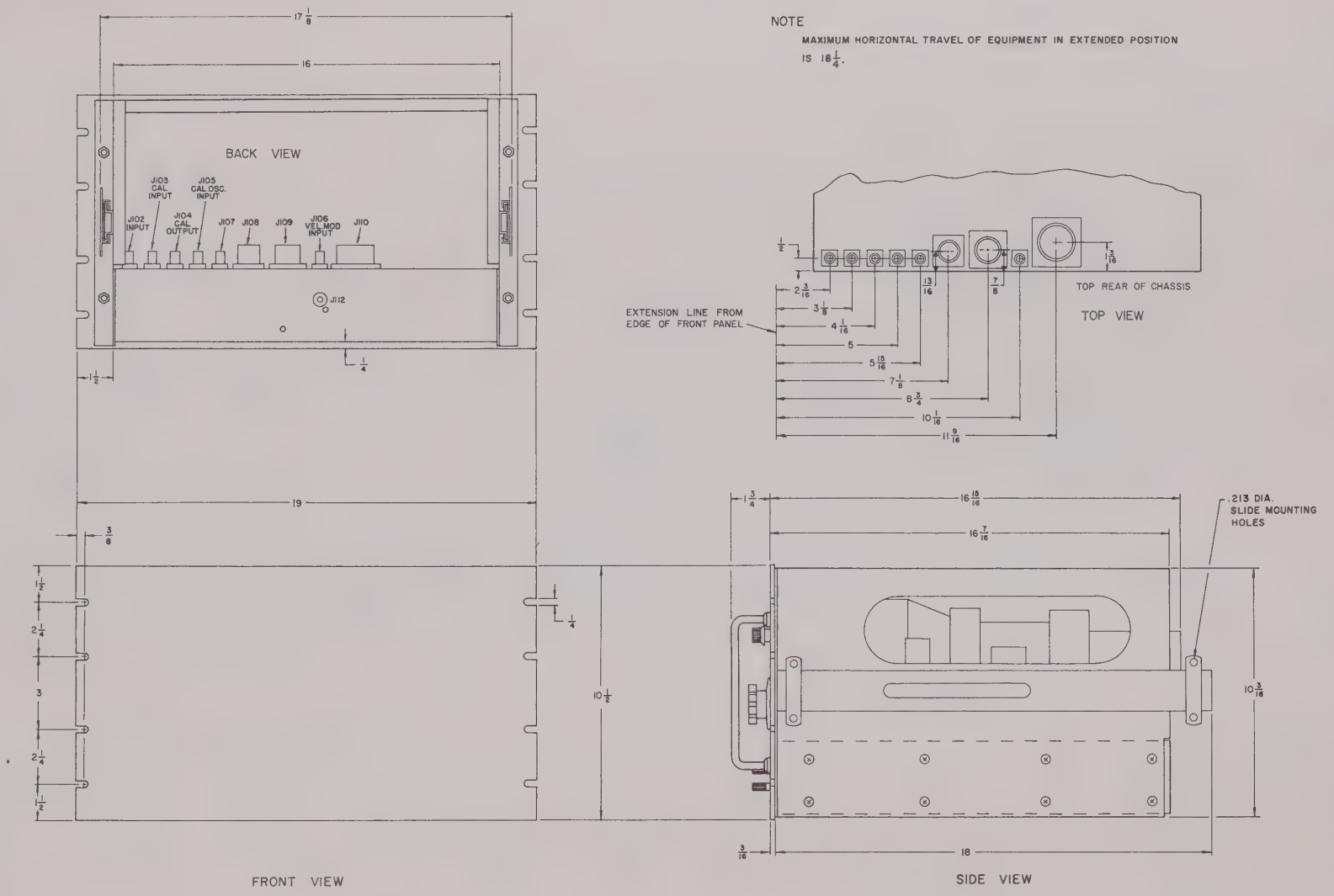

Figure II-2. Outline Dimensional Drawing, Model TMI-1b.

2. Turn the TMP-1b POWER switch to ON. The pilot light should go on at once and a moving dot should appear across the base of the TMI-1b screen after a few moments. The moving dot will be called the baseline trace throughout the manual.

CAUTION

If a stationary dot appears on the screen, turn the power off and refer to Chapter V for appropriate action.

3. Allow a 20-minute warm-up period. If a state of unbalance exists, as evidenced by a deflection called the unbalance pip on the left side of the screen (see Figure III-1a) then set PHASE BALANCE and FINE BALANCE controls so that their knob markers are pointing upward. Adjust COARSE BALANCE for minimum deflection of the unbalance pip. Then adjust PHASE BALANCE and FINE BALANCE together for minimum deflection of the unbalance pip. To save time, when an approximate condition of balance is achieved, the unbalance pip can be moved off the screen using the LOGarithmic 350 ~ control.

4. The baseline trace should coincide with the baseline of the calibrated screen. If there is a lack of parallelism, it is necessary to rotate the cathode-ray tube. This can be done after loosening one of the two screws holding the crt socket clamp. Be sure to retighten the screw after the adjustment is completed. Be sure that the crt is fully forward.

If the baseline trace does not coincide with the screen base, a suitable adjustment of the screwdriver-adjust VERTical POSition control on the TMI-1b should be made.

5. FOCUS, BRILLIANCE, and ASTIGmatism are adjusted as required for a suitable trace. FOCUS and ASTIGmatism should be set for a clear, sharp uniform trace. BRILLIANCE should be set at the minimum point of suitable visibility. Do not use the BRILLIANCE control to compete with external light falling on the TMI-1b screen but rather shield the screen from the external light.

6. To check equipment operation follow steps 2, 3, 4, 5, 6, and 7 of Paragraph III-1,a. Check the input section of the equipment by connecting a convenient signal to the INPUT of the TMI-1b. Set the INPUT LEVEL controls completely clockwise, the SWEEP RANGE SELECTOR to LOGarithmic SCALE MULTIPLIER to X1, and SCALE SELECTOR to LINear. Adjust the input for full scale deflection. Turn SCALE MULTIPLIER to X10. The pip height should be 0.1 on the LINear screen scale. Turn SCALE SELECTOR to LOGarithmic and SCALE MULTIPLIER to X1. The pip height should now be 0 DB on the LOGarithmic screen scale. Counter clockwise rotation of the INPUT LEVEL controls should reduce the pip height to the degree indicated by the panel calibrations.

b. TMC-1a USED AS AN ADJUNCT TO THE TMI-1b.

1. Set the TMI-1b front-panel controls as follows:

SWEEP RANGE SELECTOR . . . . . CALibration*
INPUT LEVEL, CONTINUOUS . . . MINimum
INPUT LEVEL, STEP 0
SCALE MULTIPLIER X10
SCALE SELECTOR . . . . . LINear
VIDEO FILTER . . . . . OUT

NOTE

The following TMI-1b front-panel controls are inoperative when the SWEEP RANGE SELECTOR is set on CALibration.

FREQuency MARKERS
LINear 350 ~
LOGarithmic 350 ~
LOGarithmic 5 KC
CENTER FREQuency Dial
SWEEP WIDTH Dial

2. Normally, the TMI-1b BALANCE controls need only be nominally adjusted for balance. With the OPERATION SELECTOR set to LIMITS CAL. and the CHANNEL SELECTOR set to 1, adjust the TMI-1b COARSE BALANCE control for best presentation of the limit marker pips.

3. Set the TMC-1a front-panel controls as follows:

OPERATION SELECTOR . . . . . LIMITS CALibration
CHANNEL SELECTOR . . . Desired Channel
INPUT AMPLITUDE . . . . . Completely counter-clockwise
FREQuency ADJUST . . . . . Knob marker pointing up
SWEEP WIDTH . . . . . Center of rotational range

4. Set the TMC-1a power switch to ON. The TMC-1a pilot light should go on at once.

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* The SWEEP RANGE SELECTOR of the TMI-1b must always be on CALibration when using the TMC-1a as an adjunct to the TMI-1b.

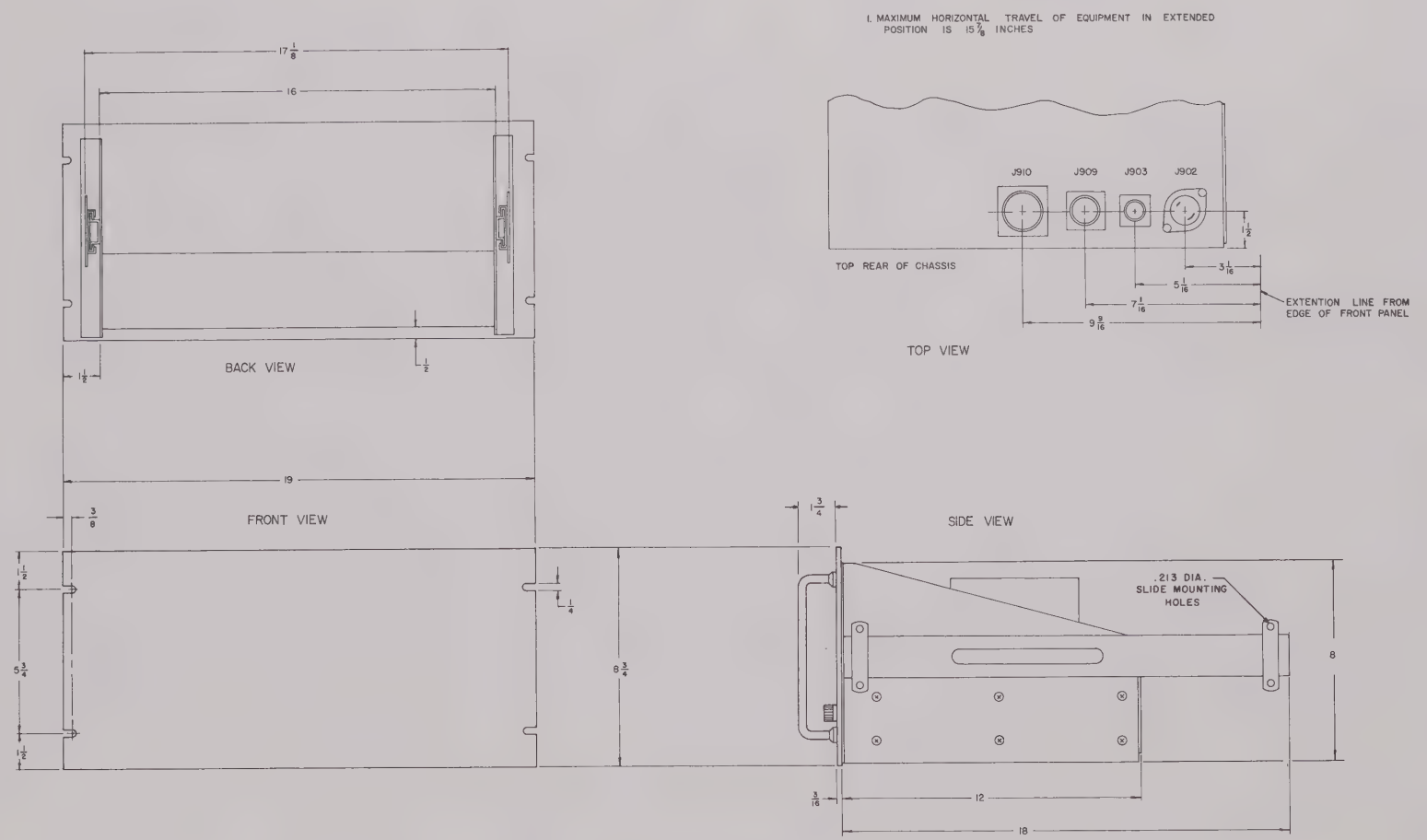

Figure II-3. Outline Dimensional Drawing, Model TMP-1b.

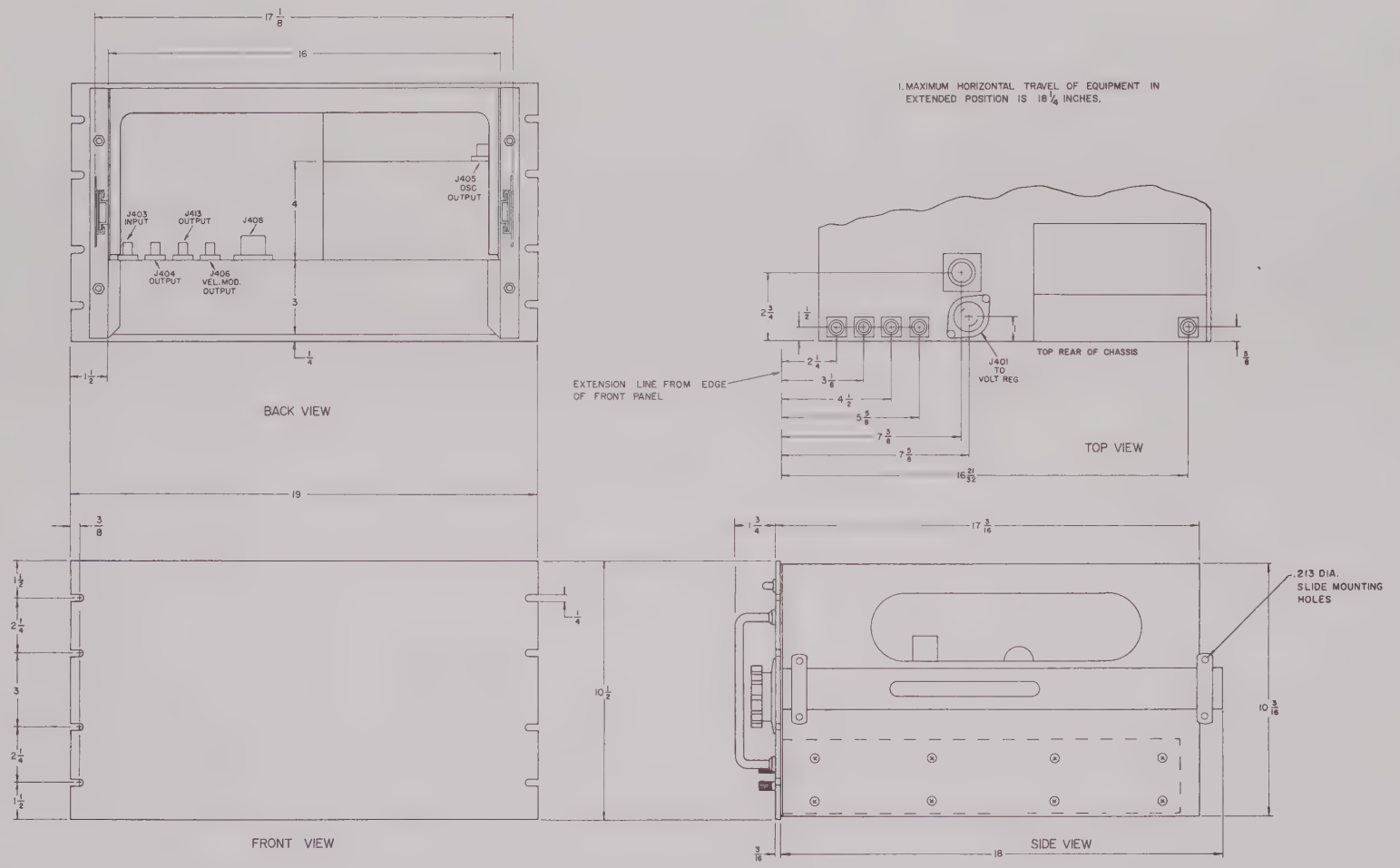

Figure II-4. Outline Dimensional Drawing, Model TMC-1a.

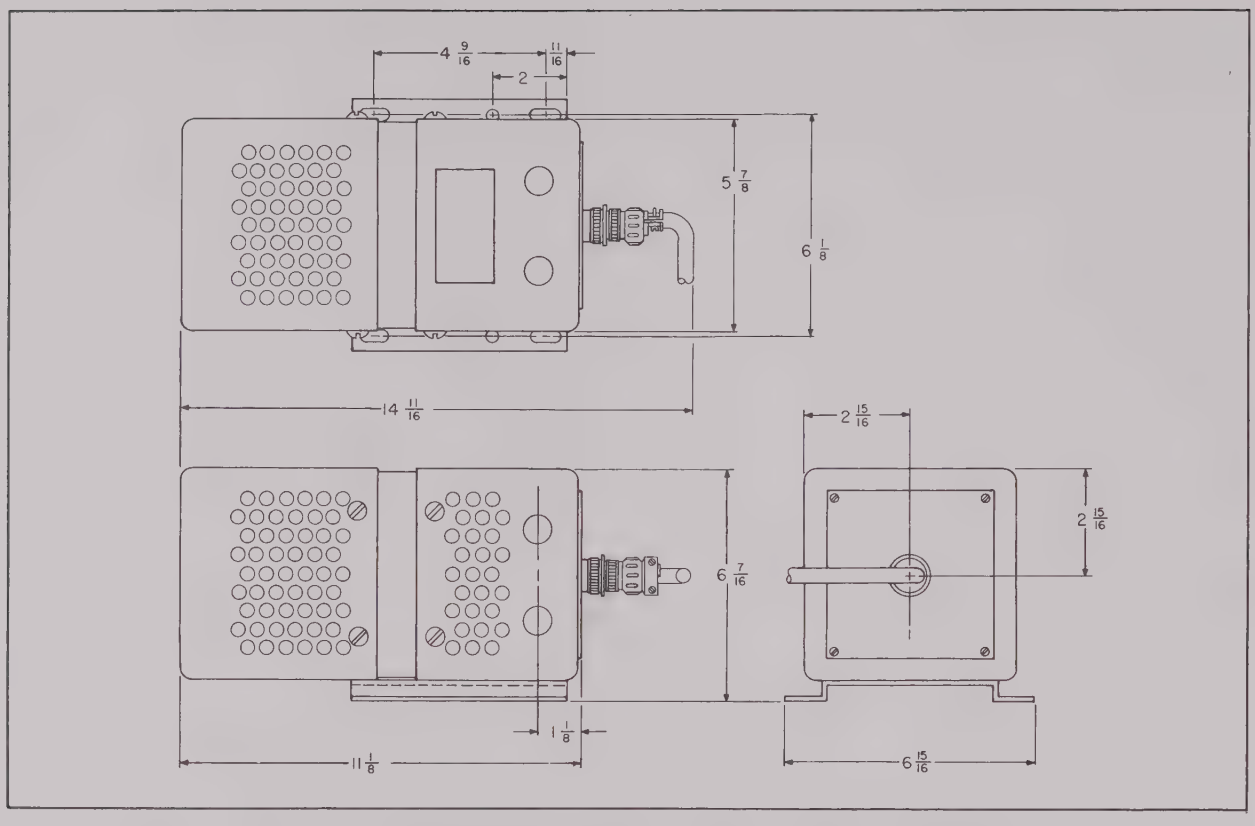

Figure II-5. Outline Dimensional Drawing, Constant-Voltage Transformer T3017-1.

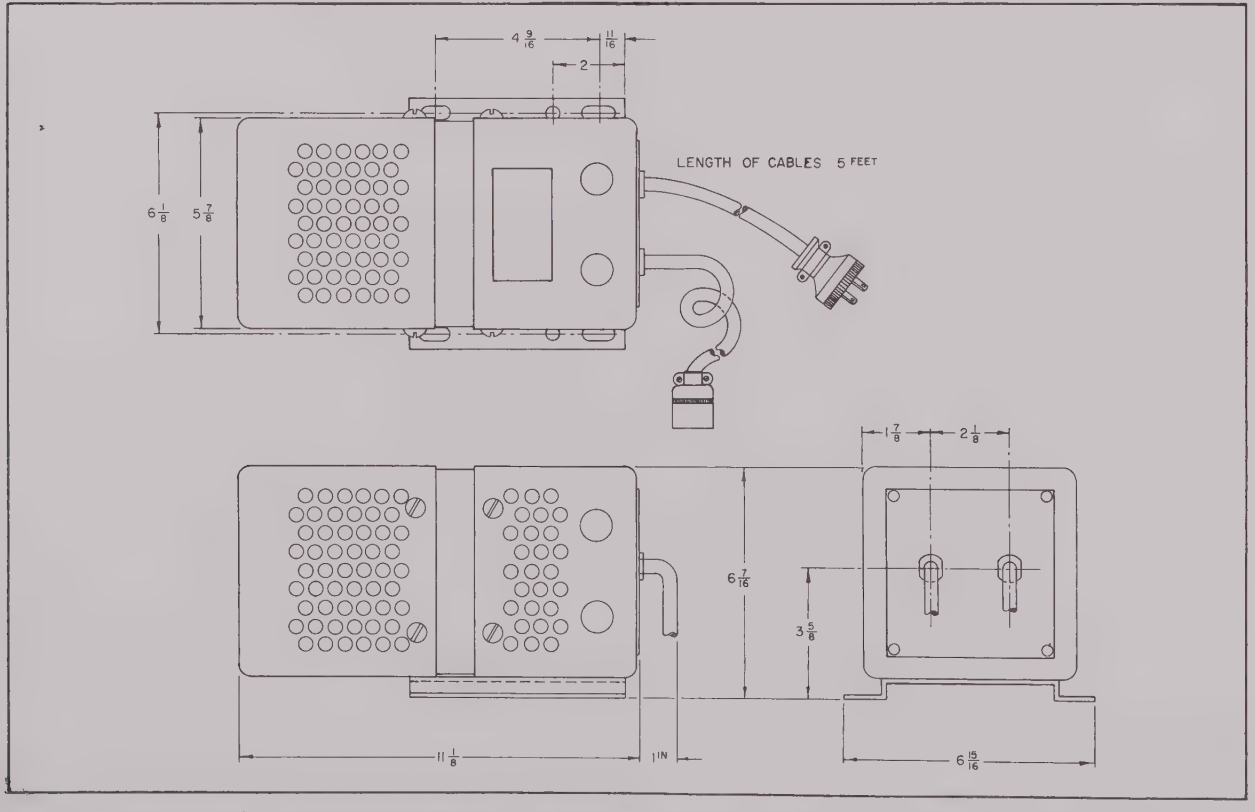

Figure II-6. Outline Dimensional Drawing, Constant-Voltage Transformer T3017-2.

NOTE

The upper right hand corner of the TMC-1a contains three indicator lamps. When the TMC-1a OPERATION SELECTOR is on LIMITS or CENTER CALibration, the lamp marked SWEEP RATE will go on and off indicating the sweep rate of the equipment. When the OPERATION SELECTOR is on other than CALibration, this lamp will be continually lit. Failure of one of the CHANNEL OUTPUT lamps to light or flickering of the lamps indicated failure of the equipment to deliver correct output signals. However, the fact that both CHANNEL OUTPUT lamps are on does not necessarily mean that the correct output is being supplied.

5. It is normally not necessary to make adjustment of FOCUS, BRILLIANCE or ASTIGmatism.

Normally if HORizontal POSition and LINE SIZE are set correctly with the TMI-1b SWEEP RATE SELECTOR on LINear or LOGarithmic (so that the baseline trace extends from the middle of the "0" of the LINear amplitude screen calibration to the left edge of the "2" in the -20 db LOGarithmic amplitude calibration) it will not be necessary to readjust these controls when switching to CALibration. If the horizontal position of the trace is sufficiently to the left to cause error, then the HORizontal POSition control should be used to set the baseline trace so that it starts in the middle of the "0" of the LINear amplitude screen scale. Note that this will necessitate readjustment when switching the SWEEP RANGE SELECTOR to LINear or LOGarithmic.*

6. Adjust the TMI-1 SCALE ILLUMINATION control as required.

7. **NOTE:** Unless the TMI-1b and TMC-1a have been given a half-hour warm-up period, there may be some degree of screen presentation drift.

Rotate the TMI-1b INPUT LEVEL controls clockwise until a suitable marker-pip height is obtained. See Figure 1-2. Rotate the TMC-1a FREQuency ADJUST. This should cause the two marker pips to shift either to the left or the right since rotation of this control changes the frequency that will result in a pip at the center of the TMI-1b screen. Rotate the TMC-1a SWEEP WIDTH control. Clockwise rotation increases the sweep width of the equipment causing the pips to move closer together. Counterclockwise rotation causes the opposite to occur.

NOTE

With the TMC-1a SWEEP WIDTH control in the center of its rotational range, the limit-marker pips for channels 9 and higher should fall approximately under the outermost SWEEP WIDTH divisions on the TMI-1b screen (±5), the pips for channels 7 and 8 should fall approximately under ±4-1/2 divisions, the pips for channels 5 and 6 under the ±4 divisions, the pips for channels 3 and 4 under the ±3-1/2 divisions, and the pips for channels 1 and 2 under the ±3 divisions.

Connect to the TMI-1b front-panel input connector, a signal of between 10 millivolts and 10 volts at a frequency that falls between the frequency limits of the channel to which the CHANNEL SELECTOR is set (e.g., between 59.5 kc and 80.5 kc for channel E). This should result in a pip on the TMI-1b screen that falls between the limit-marker pips. Its position with respect to the marker pips will depend on the frequency relationship between the signal and the markers. Adjust the TMC-1a INPUT AMPLITUDE for suitable signal-pip height. Do not use the TMI-1b INPUT LEVEL controls since these controls will attenuate both markers and input signals equally.

8. Set the OPERATION SELECTOR to CENTER CALibration. Check similarly to step 7. The SWEEP WIDTH control should be in approximately the center of its rotational range so that the selected channel is completely on the screen. After checking CENTER CALibration operation return the OPERATION SELECTOR to LIMITS CALibration

9. Repeat step 7 and 8 for each position of the CHANNEL SELECTOR.

c. TMC-1a USED BY ITSELF AS A SOURCE OF MARKER FREQUENCIES FOR DISCIMINATOR ALIGNMENT.

1. Set the TMC-1a CHANNEL SELECTOR to channel 1.

Set the OPERATION SELECTOR to LOWER LIMIT.

NOTE

When the OPERATION SELECTOR is on other than CALibration, the following front-panel controls are inoperative.

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* This condition is indicative of improper chassis control settings. See Chapter V.

FREQuency ADJUST
SWEEP WIDTH
INPUT AMPLITUDE

CAUTION

Be sure that either external interconnection is made between pins "A" and "B" of receptacle J408 (by using the supplied mating plug that has pins "A" and "B" connected) or that J408 of the TMC-1a is interconnected with J108 of the TMC-1a is interconnected with J108 of the TMC-1a (and the SWEEP RANGE SELECTOR of the TMI-1b is on CALibration).

2. Connect an oscilloscope or some other suitable output indicator to the OUTPUT connector.*

3. Turn the POWER switch to ON. Allow a 5-minute warm-up period. An approximately rectangular waveshape will be observed on the screen of the oscilloscope thereby confirming the fact that the TMC-1a is delivering an output signal.

4. The presence of output signal should be checked on all channels with the OPERATION SELECTOR set to UPPER LIMIT, CENTER FREQuency, and LOWER LIMIT. The frequency should also be checked by the use of any available accurate means of measuring frequency.

5. Check output on the TMC-1am with the OPERATION SELECTOR set to the AUTOmatic position.

---

* The TMI-1b may be used. Connect the TMC-1a OUTPUT to the TMI-1b INPUT. Operate the TMI-1b with the SWEEP RANGE SELECTOR set either to LINear or LOGarithmic. In this case, remove the cable between J408 of TMC-1a and J108 of TMI-1b and interconnect pins "A" and "B" of J408 by means of the supplied mating plug that has pins "A" and "B" interconnected.

CHAPTER III
OPERATING INSTRUCTIONS

III-1. PRELIMINARY ADJUSTMENTS, MODELS TMI-1b and TMC-1a

a. PRELIMINARY ADJUSTMENTS, MODEL TMI-1b.

1. Depending on the equipment usage, either the calibrated crt screen with the sub-carrier center-frequency scale or the screen with the full logarithmic-frequency scale should be used. The calibrated screen may be changed as follows. Note that when screens are changed some slight readjustment of LOGarithmic 350~ and LOGarithmic 5 KC may be required to compensate for slight differences in the placement of the screens. See Paragraph III-1, a, 6(a).

(a) The bezel-hood assembly is held in place by means of four captive fasteners. The fasteners are unscrewed in a counterclockwise direction. The bezel-hood assembly can then be removed.

(b) Positioned in the bezel-hood assembly are four items, the amber filter, a circular aluminum mask (painted black on the side toward the crt face), the calibrated screen and another circular aluminum mask (painted black on the side away from the crt face), in that order outward from the crt face. The four items can lift out from the four positioning screws. Remove the filter, the mask that was nearest the crt, and the calibrated screen, leaving the mask that was furthest from the crt.

(c) After removing the three items, the desired calibrated screen is placed over the four positioning screws. Be careful to see that the orientation is correct. Note that the calibrated side of the screen must be toward the crt face. Next place the circular aluminum mask over the positioning screws so that the black side will be towards the crt face. Finally, place the amber filter over the positioning screws. Note that the filter and the mask have large holes to pass light from the edge lighting bulbs. Do not use these holes for mounting but rather the four small mounting holes.

(d) The bezel-hood assembly may now be reconnected to the front panel of the TMI-1b by means of the captive fasteners.

2. Set the following TMI-1b front-panel controls as listed.

SWEEP RANGE SELECTOR. . . . . LOGarithmic
SCALE SELECTOR . . . . . LOGarithmic
SCALE MULTIPLIER. X10
INPUT LEVEL, CONTINUOUS . . . MAXimum
VIDEO FILTER. . . . . OUT

3. Turn the TMP-1b POWER switch to ON. The baseline trace should appear in a few moments. If necessary, reset FOCUS, BRILLIANCE, and ASTIGmatism for a suitable trace. See Chapter II, Paragraph II-4a. 5.

NOTE

Allow a 30-minute warm-up period. Although the instrument may be used during a warm-up period, considerable adjustment may be necessary for accurate measurements.

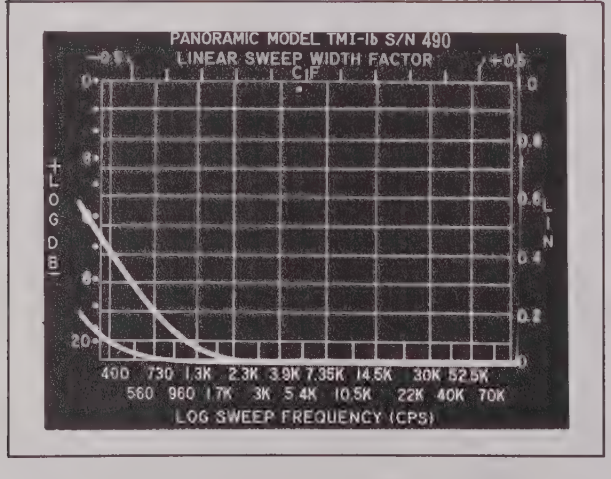
PANORAMIC MODEL TMI-1b S/N 490
LINEAR SWEEP WIDTH FACTOR
CIF
+LOG DB
LIN
400 730 1.3K 2.3K 3.9K 7.35K 14.5K 30K 52.5K
560 960 1.7K 3K 5.4K 10.5K 22K 40K 70K
LOG SWEEP FREQUENCY (CPS)

Figure III-1a. LOGarithmic Scan Unbalance

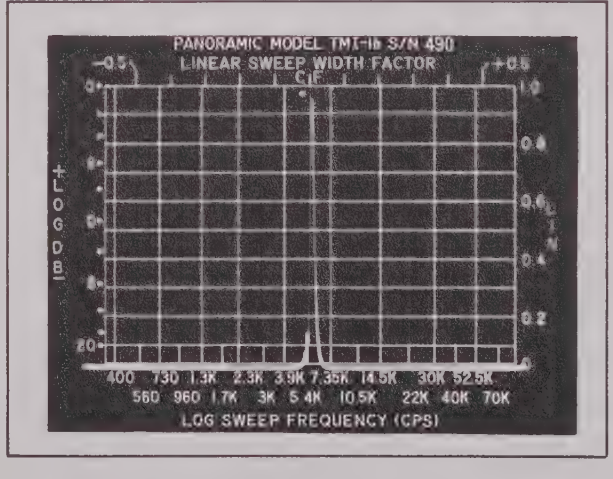
PANORAMIC MODEL TMI-1b S/N 490
LINEAR SWEEP WIDTH FACTOR
CIF
+LOG DB
LIN
400 730 1.3K 2.3K 3.9K 7.35K 14.5K 30K 52.5K
560 960 1.7K 3K 5.4K 10.5K 22K 40K 70K
LOG SWEEP FREQUENCY (CPS)

Figure III-1b. LINear Scan Unbalance

4. If required, adjust the BALANCE controls for maximum suppression of the local-oscillator deflection that is present when the mixer circuit is not properly balanced. When the SWEEP RANGE SELECTOR is on LOGarithmic, imbalance evidences itself as a deflection on the left side of the screen. On LINear, imbalance evidences itself as a pip in the mid portion of the screen when the CENTER FREQuency is set at 0. This is illustrated in Figure III-1.

Set PHASE BALANCE and FINE BALANCE so that their knob markers are pointing upward. Adjust COARSE BALANCE for minimum deflection of the imbalance pip. Then adjust PHASE BALANCE and FINE BALANCE together for minimum deflection of the imbalance pip. (If it is necessary to bring FINE BALANCE to the end of its rotational range, it will be necessary to make a slight adjustment of COARSE BALANCE.)

NOTE

Some degree of balance adjustment may be required whenever the setting of the SCALE MULTIPLIER is changed.

5. Check the baseline trace for size and position.

NOTE

When viewing the calibrated screen, the operator should keep his sight directly in line with the center of the screen and at a distance of approximately 15 inches. The screen calibrations have been made from this position. Hence, viewing the screen from any other position introduces parallax error. See Figure III-2.

The baseline trace should extend from the center of the "0" of the LINear amplitude scale to the left edge of the "2" in the -20 db of the LOGarithmic amplitude scale. This is illustrated in Figure III-3.

If this is not the case, adjust LINE SIZE and

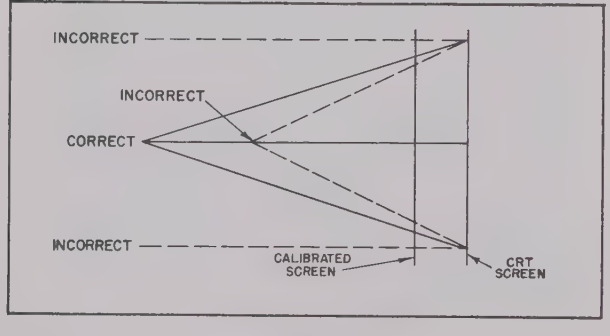

Figure III-2. Illustration of Correct Viewing of Screen.

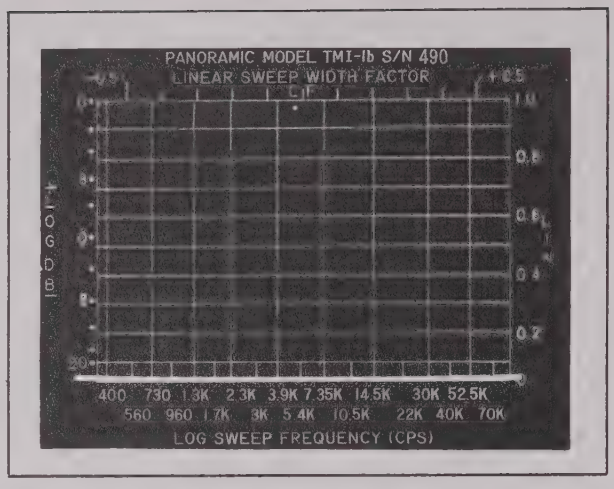
PANORAMIC MODEL TMI-1b S/N 490
LINEAR SWEEP WIDTH FACTOR
LOG DB
400 730 1.3K 2.3K 3.9K 7.35K 14.5K 30K 52.5K
560 960 1.7K 3K 5.4K 10.5K 22K 40K 70K
LOG SWEEP FREQUENCY (CPS)

Figure III-3. Baseline Trace Size and Position.

HORizontal POSition together to obtain the correct size and position with the SWEEP RANGE SELECTOR on LINear.

NOTE

It may take approximately 30 minutes of warm-up for the trace to reach its operating size.

6. Internal markers are provided to facilitate adjustment of the equipment for correctness of frequency calibration.

(a) LOGarithmic Sweep

(1) Set SCALE MULTIPLIER to X1. All other control settings are the same as those listed in paragraph 2.

(2) Hold FREQuency MARKERS to the ON position. This should result in the appearance on the TMI-1b screen of at least 3 pips. A pip should appear at approximately 85 KC on the screen and another at 5 KC. Note that on the screen that is frequency calibrated in terms of channel mid-frequencies, 5 KC is indicated by a dot between "0" and the first division to the left of "0" on the SWEEP WIDTH calibration at the top of the screen.* At the low frequency end of the screen as many as three pips may appear. If they do, then the two outside pips are 350 cps on both sides of the oscillator. The pip in the middle is the local oscillator pip (indicating imbalance). This is illustrated in Figure III-4. See also Figure I-2c.

* In some cases, the 5 KC point falls so close to the "0" of the SWEEP WIDTH calibration that the dot is omitted.

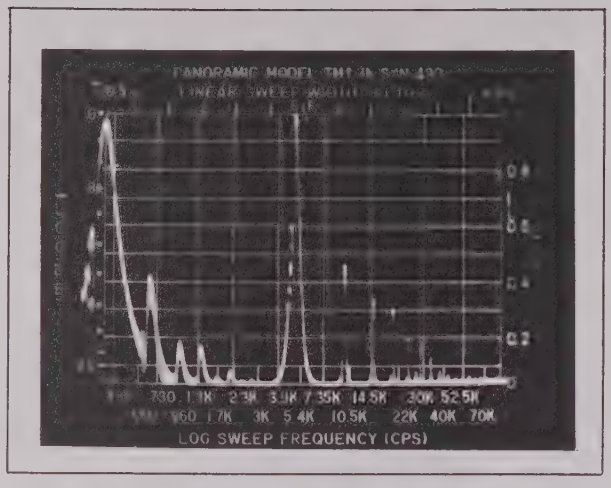

Figure III-4. Internal Markers. LOGarithmic Frequency Presentation.

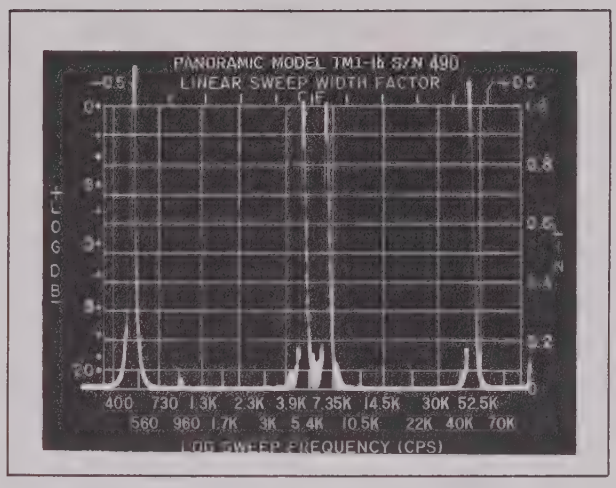
PANORAMIC MODEL TM1-16 S/N 490
LINEAR SWEEP WIDTH FACTOR
LOG DB
400 730 1.3K 2.3K 3.9K 7.35K 14.5K 30K 52.5K
560 960 1.7K 3K 5.4K 10.5K 22K 40K 70K
LOG SWEEP FREQUENCY (CPS)

Figure III-5. Internal Markers. LINear Frequency Presentation.

NOTE

The 350-cps and 5-kc pips should be approximately full scale and the 85-kc marker pip approximately -4 db on the logarithmic-amplitude scale.

(3) If the two 350-cps pips are not present, rotate LOGarithmic 350 ~ clockwise until they are.

(4) Then reverse the direction of rotation of LOGarithmic 350 ~ until the left 350-cps pip (and the imbalance pip, if present) moves off the screen.

(5) Then adjust LOGarithmic 350 ~ until the remaining pip falls under the 350 cps screen calibration (left edge of screen calibrations).

(6) Adjust LOGarithmic 5 KC until the 5-kc marker pip falls under the 5 KC screen calibration. (This is a dot on the screen calibrated in channel mid-frequencies. See (2) above.

(7) Repeat (5) and (6) until both 350 CPS and 5 KC are correct.

(8) If the above cannot be done using LOGarithmic 350 ~ then set this control to the center of its rotational range and follow steps (3) to (7) using 350 CYC PAD in place of LOGarithmic 350 ~ .

(b) LINear Sweep

(1) Set the SWEEP RANGE SELECTOR to LINear.

NOTE

In switching from LOGarithmic to LINear to LOGarithmic with the SWEEP RANGE SELECTOR allow a few minutes for stabilization.

(2) Set the CENTER FREQuency Dial to 350 cps. (This is a dot between 0 and 1 KC on the dial).

(3) Set scale selector to LINear.

(4) Set the SWEEP WIDTH Dial to 10 KC.

(5) With the FREQuency MARKERS switched to the ON position a screen presentation such as that illustrated in Figure III-5 should appear.*

(6) Slowly rotate the SWEEP WIDTH Dial to 100 cps (completely counterclockwise), keeping the right hand 350-cps pip at the center of the screen (under the "0" of the SWEEP WIDTH calibration at the top of the screen) with LINear 350 ~ .

(c) Readjust the BALANCE controls if required.

7. Adjust SCALE ILLUMINATION as required.

---

* The 5-kc pip on the left side of the screen may not appear, or may appear in a position other than that shown, because of nonlinearity of the sweep width to the left of the zero pip.

b. PRELIMINARY ADJUSTMENTS, MODEL TMC-1a.

1. As an adjunct to the Panoramic Model TMI-1b for the calibration of telemetry channels.

(a) Allow at least a half-hour warm-up period for both the TMI-1b and TMC-1a. The instruments are usable during the course of the warm-up, but the presentation may drift, thereby necessitating adjustment with the FREQuency ADJUST and SWEEP WIDTH controls of the TMC-1a. Some degree of adjustment may be necessary for the following half hour. After one hour of warm-up operation, the equipments should be comparatively stable.

Adjustments should be made as required.

(b) Set the front-panel controls as listed in Paragraph I-4.b.1 and Paragraph II-4.b.3.

NOTE

(1) The following TMI-1b front-panel controls are inoperative when the SWEEP RANGE SELECTOR is set on CALibration.

FREQ. MARKERS
LINear 350~
LOGarithmic 350~
CENTER FREQuency Dial
SWEEP WIDTH Dial

(2) Normally, the TMI-1b BALANCE controls need only be nominally adjusted for balance. With the OPERATION SELECTOR set to LIMITS CALibration and the CHANNEL SELECTOR set to 1, adjust the TMI-1b COARSE BALANCE control for best presentation of the limit-marker pips. See, however, Chapter III, Paragraph 2.c.3. Note.

(3) See Paragraph II-4.b.5. for a discussion of the use of TMI-1b controls affecting the baseline trace.

(c) Connect the source of signals to the TMI-1b front panel INPUT connector.

CAUTION

The TMC-1a front panel INPUT connector is only connected to the TMI-1b front panel INPUT connector when the TMI-1b SWEEP RANGE SELECTOR is on CALibration. For this reason it is normally preferable to connect the source of signals to the TMI-1b INPUT since a signal connected to the TMC-1a INPUT can only be seen on the TMI-1b screen when the TMI-1b SWEEP RANGE SELECTOR is set on CALibration. A signal connected to the TMI-1b INPUT can be seen on all three positions of the SWEEP RANGE SELECTOR, i.e., LINear, LOGarithmic and CALibration.

(d) Adjust the TMI-1b INPUT LEVEL controls for a suitable marker-pip height on the screen of the TMI-1b (normally full scale). Adjust INPUT AMPLITUDE (TMC-1a) for a suitable amplitude of presentation on the TMI-1b screen of the input signals. Adjust FREQuency ADJUST (TMC-1a) and SWEEP WIDTH (TMC-1a) for a presentation of the limits-marker pips that is suitable spaced and symmetrical about the center of the screen. Frequency readings are made using the linear-frequency screen scale (top of screen).

(e) If calibration of channel mid-frequency is required, switch the TMC-1a OPERATION SELECTOR to CENTER CALibration. In place of the limit markers, a center marker will appear. Otherwise there is no change in the screen presentation or procedures.

One cycle of LIMITS CALibration operation consists of the following.

First 1/4 second: Upper-limit frequency-marker pip for the channel selected appears on the right side of the screen.

Next 1/4 second: Lower-limit frequency-marker pip for the channel selected appears on the left side of the screen.

Next 1/2 second: The sub-carrier of the selected channel appears on the screen. Where it appears is a function of the frequency relationship between the limit frequencies and the subcarrier.

(2) During the portion of the operating cycle in which the limit-marker pips appear on the TMI-1b, and only in this part of the cycle, switching transients will result in the appearance of a series of small pips in the valley between the two marker pips. These pips are almost non-existent on the high-frequency channels. On the lowest-frequency channels the pips are on the right-hand side of the skirt of the lower-limit marker. Since their amplitude is much below that of the markers, they cannot be confused with the markers. They are not present during the portion of the operating cycle in which the

sub-carrier appears and therefore they cannot be confused with the sub-carrier.

(3) One cycle of CENTER CALibration operation consists of the following.

First 1/2 second: Mid-frequency marker pip for the channel selected appears in the middle of the screen.

Next 1/2 second: The sub-carrier of the selected channel appears on the screen. Where it appears is a function of the frequency relationship between the marker and the sub-carrier.

(f) Adjust the TMI-1b SCALE ILLUMINATION control as required.

2. Model TMC-1a used as a source of marker frequencies for discriminator calibration.

(a) No preliminary adjustments are required. Note that in this mode of operation (OPERATION SELECTOR set to UPPER LIMIT, CENTER FREQuency, or LOWER LIMIT) the following front-panel controls are inoperative.

FREQuency ADJUST
SWEEP WIDTH
INPUT AMPLITUDE

CAUTION

Be sure that external interconnection is made between pins "A" and "B" of receptacle J408 (by means of the supplied mating plug that has pins A and B interconnected or that J408 of the TMC-1a is interconnected with J108 of the TMI-1b (and the SWEEP RANGE SELECTOR of the TMI-1b is on CALibration).

III-2. OPERATING ADJUSTMENTS

Once the preliminary adjustments and calibration checks have been made, the instrument is ready for use. If the equipment is used during the warm-up period, frequent calibration adjustments may be necessary.

CAUTION

When switching from LINear or LOGarithmic to CALibration or from CALibration to LINear or LOGarithmic, a five-minute stabilization period should be allowed. Although the equipment is useable during this period, there may be some degree of frequency instability at the low end during this five-minute stabilization period.

a. RELATIVE VOLTAGE MEASUREMENTS USING MODEL TMI-1b.

1. Set the following controls to the listed positions.

SWEEP RANGE SELECTOR . . . . . LOGarithmic
SCALE MULTIPLIER X1
SCALE SELECTOR . . . . . LOGarithmic
INPUT LEVEL, CONTINUOUS . . . MAXimum
INPUT LEVEL, STEP 0
VIDEO FILTER . . . . . OUT

2. Connect the source of signals to the TMI-1b front panel INPUT connector. Note that the equipment has an additional INPUT connector on the rear of the chassis (type BNC).

3. Rotate the INPUT LEVEL controls so that the largest signal present does not exceed full scale.

CAUTION

All voltage measurements must be made with the INPUT LEVEL controls in these or less sensitive positions (counterclockwise rotation of the INPUT LEVEL controls decreases the sensitivity) to prevent overload, thereby preventing spurious indications.

4. The SCALE SELECTOR may now be set on LINear and the SCALE MULTIPLIER on X10 if such settings are more suitable for the measurements. On LINear, stronger signals may go beyond full scale deflection but this is normal and permissible providing the conditions of 1, 2, and 3 are satisfied.

CAUTION

When the SCALE SELECTOR is on LOGarithmic, the SCALE MULTIPLIER must always be set on X1 to avoid overload. When the SCALE SELECTOR is on LINear, the SCALE MULTIPLIER may be set on either X1 or X10.

5. With the SCALE SELECTOR on LINear, amplitude ratios of 10:1 may be measured simultaneously. In this case relative amplitudes are read on the amplitude scale on the right side of the screen. The use of the SCALE MULTIPLIER provides an additional 10 times of range on LINear thereby allowing amplitude ratios of as great as 100:1 to be measured.

6. With the SCALE SELECTOR on LOGarithmic, amplitude ratios of as great as 100:1 (40 db) may be measured. In this case relative amplitudes are read on the amplitude scale on the left side of the screen.

If read correctly, second harmonics that are as much as 100-times down from the fundamental may be measured with an accuracy of ±1.5 db. Visual beats may appear because of the closeness in frequency of the fundamental and second harmonic. To obtain the second-harmonic amplitude it is necessary to measure the second-harmonic pip at the center of the beats. This is illustrated in Figure III-6. The amplitude ratio in a is greater than that in b resulting in a somewhat different presentation.

7. If a closer examination of a portion of the frequency spectrum is desired, set the SWEEP RANGE SELECTOR to LINear and set the SWEEP WIDTH and CENTER FREQ. Dial for the desired frequency band.

NOTE

When switching the SWEEP RANGE SELECTOR from LINear to LOGarithmic or LOGarithmic to LINear, a few minutes should be allowed for stabilization.

Figure I-4 indicates the minimum frequency separations required to measure signals of unequal amplitudes for various settings of the SWEEP WIDTH Dial. The amplitude accuracy will be within 1 db (excluding flatness errors).

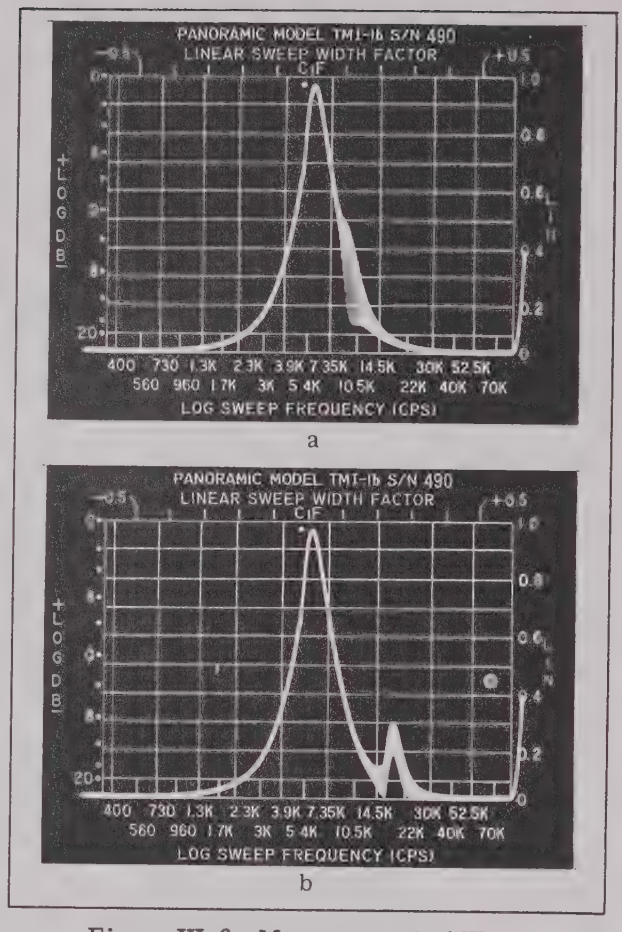
PANORAMIC MODEL TMI-1b S/N 490
LINEAR SWEEP WIDTH FACTOR
CIF
+LOG DB
400 730 1.3K 2.3K 3.9K 7.35K 14.5K 30K 52.5K
560 960 1.7K 3K 5.4K 10.5K 22K 40K 70K
LOG SWEEP FREQUENCY (CPS)
a
PANORAMIC MODEL TMI-1b S/N 490
LINEAR SWEEP WIDTH FACTOR
CIF
+LOG DB
400 730 1.3K 2.3K 3.9K 7.35K 14.5K 30K 52.5K
560 960 1.7K 3K 5.4K 10.5K 22K 40K 70K
LOG SWEEP FREQUENCY (CPS)
b

Figure III-6. Measurement of Weak Second Harmonics.

b. FREQUENCY MEASUREMENTS USING MODEL TMI-1b.

1. Set the following controls to the listed positions.

SWEEP RANGE SELECTOR	LOGarithmic
SCALE SELECTOR	LINear
SCALE MULTIPLIER	X1
INPUT LEVEL, CONTINUOUS	MAXimum
INPUT LEVEL, STEP	0
VIDEO FILTER	OUT

2. Connect the source of signals to the TMI-1b front panel INPUT connector.

3. Adjust the INPUT LEVEL controls for readable pip height. The overload restrictions noted in paragraph III-2 should be followed.

4. Check the frequency calibrations using the internal markers. Readjust the equipment as required. See Paragraph III-1.a.6.

5. The frequency of the pips may be read directly from the logarithmic frequency calibrations on the bottom of the screen. Note that two screens are supplied, one calibrated from 350 CPS to 85 KC and the other calibrated in terms of channel mid-frequency.

6. For closer examination of a portion of the spectrum, set the SWEEP RANGE SELECTOR to LINear.

NOTE

Allow a few minutes for stabilization.

Set the SWEEP WIDTH Dial to 20 KC. Rotate the CENTER FREQuency Dial until the desired portion of the frequency spectrum appears on the screen. This portion may be "magnified" as required by reducing the SWEEP WIDTH. The setting of the CENTER FREQuency Dial indicates the frequency of the signal at the center of the screen. Frequencies above and below the center of the screen are read above and below the "0" of the SWEEP WIDTH calibrations at the top of the screen. Each division represents one-tenth

of the sweep width set on the SWEEP WIDTH Dial. It should be noted that the calibrations of the CENTER FREQuency and SWEEP WIDTH Dials are nominal. If more accurate frequency readings are required, a frequency-accurate signal may be fed into the TMI-1b to determine exact locations of the desired frequencies. To do this it is first necessary to remove the signals that are being measured or isolate them properly.

NOTE

In the LINear (and also CALibration) position of the SWEEP RANGE SELECTOR, the VIDEO FILTER switch may be used to introduce additional filtering at the output of the detector to reduce spurious beats that result when two signals are close in frequency. However, since the video filter integrates the pulse as seen on the screen, it should not be used when amplitude measurements are being made. Note also that the video filter has an adverse effect on resolution.

c. MODEL TMC-1a USED AS AN ADJUNCT TO THE PANORAMIC MODEL TMI-1b FOR THE CALIBRATION OF TELEMETRY CHANNELS.

1. Once the preliminary adjustments have been made, the equipment is ready for operation. Be sure to allow at least a 5-minute warm-up period for both the TMI-1b and TMC-1a.

2. Connect the source of signals and adjust the equipment in accordance with the section on Preliminary Adjustments, Paragraph III-1.b.1.

Set OPERATION SELECTOR to either LIMITS CALibration or CENTER CALibration depending on the markers desired.

It should be noted that in order to obtain a clean presentation on the lower-frequency channels it may be necessary to increase the sweep width with the TMC-1a SWEEP WIDTH control.

3. Frequencies are read on the frequency scale at the top of the screen. This is a linear scale. The positional relationship between the marker pips and the sub-carrier pip indicates the frequency relationship between the marker frequencies and the sub-carrier frequency. To obtain the sharpest pip so as to make for better comparisons, the TMI-1b SCALE SELECTOR should be kept on LIN (particularly on the low channels).

For example, if the CHANNEL SELECTOR is on 1, the limit-marker frequencies are 370 cps and 430 cps. If the marker pips are under the third divisions from "0" on the CRT screen SWEEP WIDTH scale and the sub-carrier pip is one division to the right of the "0" on the screen scale, then the sub-carrier frequency is approximately 410 cps since each of the 6 divisions in this case will represent 10 cps. To determine, for example, what range of voltages need be applied to the sub-carrier oscillator to obtain 7.5% deviation (or 15% on the optional channels), the voltage is varied until the sub-carrier pip is superimposed first with the lower-limit marker pip and then with the upper-limit marker.

NOTE

To aid in distinguishing between marker pips and sub-carrier pips, the marker pips are velocity modulated. This causes a dotted presentation of the marker pip. However, lack of TMI-1b balance may result in a dotted presentation of the sub-carrier pips on the low frequency channels. This can be corrected by first adjusting the TMI-1b BALANCE controls for the cleanest presentation and then setting the TMI-1b VIDEO FILTER switch to "L" (low) or "H" (high) as required. This should be done on CHANNEL 1. Note, however, that the use of video filtering has a deleterious effect on resolution. It should be noted that the VIDEO FILTER is normally used to filter spurious beats (resulting from signals close together in frequency) whose presence would make observation difficult.

4. To condition the equipment for the examination of another channel it is only necessary to change the setting of the CHANNEL SELECTOR. If desirable, FREQuency ADJUST and SWEEP WIDTH should be adjusted so that the presentation lines up with the screen calibrations for ease of reading.

d. MODEL TMC-1a USED AS A SOURCE OF MARKER FREQUENCIES FOR DISCRIMINATOR CALIBRATION.

1. Allow a 5 minute warm-up period.

CAUTION

Be sure that either external interconnection is made between pips "A" and "B" of receptacle J408 (by means of the supplied mating plug that has pins "A" and "B" connected) or that J408 of the TMC-1a is interconnected with J108 of the TMI-1b (and the SWEEP RANGE

SELECTOR of the TMI-1b is on CALibration).

2. Connect the OUTPUT connector of the TMC-1a to the unit to be calibrated.

3. Set the CHANNEL SELECTOR to the desired channel.

4. By switching the OPERATION SELECTOR to UPPER LIMIT, CENTER FREQuency or LOWER LIMIT, the upper limit frequency, center frequency or lower limit frequency of the channel to which the CHANNEL SELECTOR is set is available at the TMC-1a OUTPUT terminals. The available frequencies are given in Chapter I, Paragraph I-5.b.

e. MODEL TMC-1am IS USED AS A SOURCE OF MARKERS FOR AUTOMATIC DISCRIMINATOR CALIBRATION.

1. Allow a 5-minute warm-up period.

CAUTION

Be sure that either external interconnection is made between pins "A" and "B" of receptacle J408 (by means of the supplied mating plug that has pins "A" and "B" connected or that J408 of TMC-am is interconnected with J108 of the TMI-1b and the SWEEP RANGE SELECTOR of the TMI-1b on CALibration)

2. Connect the OUTPUT connector of the TMC-1am to the input of all the units to be calibrated.

3. If desired, connect a meter or recorder in accordance with the instructions given in Paragraph II-3.b.2.

4. Set the CHANNEL SELECTOR to the lowest channel to be calibrated.

5. Set the OPERATION SELECTOR to the AUTOmatic position. The upper-limit frequency, center frequency, and lower-limit frequency of each channel will appear in sequential order at the output terminals of TMC-1am. The pointer on the CHANNEL SELECTOR knob will indicate the channel.

6. To turn off the automatic operation, turn the OPERATION SELECTOR to any other position. The CHANNEL SELECTOR may be operated manually providing the AUTOmatic indicator lamp has been continuously off for at least five seconds. This five-second wait must be followed strictly in order to avoid possible jamming of the CHANNEL SELECTOR.

CAUTION

DO NOT turn the Model TMC-1am off until the OPERATION SELECTOR has been switched from the AUTOmatic position and the AUTOmatic lamp has been off continuously for at least five seconds.

CHAPTER IV
THEORY OF OPERATION

IV-1. INTRODUCTION*

The Panoramic Telemetering Indicator, Model TMI-1b, a heterodyne type of instrument, consists basically of a calibrated input attenuator, band-pass filter, phase splitter, swept oscillator, balanced modulator, variable-selective intermediate-frequency amplifier, detector, video amplifier, cathode-ray tube indicator and associated sweep-and selectivity-control circuits.

By choice of operating parameters the swept-oscillator frequency is caused to vary logarithmically or linearly as desired. When operating linearly, front panel controls provide means of varying the range (sweep width) and center frequency of the swept oscillator. The swept-oscillator signal progressively heterodynes in order of frequency with those input signals passed by the input section. Oscillator and input signals are balanced out in the modulator leaving only sum and difference terms of the input and oscillator frequencies. The difference frequencies are selected by a sharply tuned i-f section. The output voltage from the i-f section is detected, amplified, and applied to the vertical-deflection plates of the cathode-ray tube. The output voltage, corresponding to a particular input frequency, is proportional to the amplitude of this input frequency.

Variation in oscillator frequency is obtained by a sawtooth-modulated reactance tube that forms part of the oscillator circuit. The sawtooth generator that supplies this modulating voltage also provides the sawtooth voltage for the horizontal sweep of the crt beam. Thus, for each point on the horizontal axis of the crt there is a corresponding swept-oscillator frequency and thus a corresponding input frequency.

The i-f section includes two variable-selective stages. The selectivity is varied by changing the sharpness of the two crystal filters in a manner that provides approximately optimum resolution at all times. The last i-f stage has provision for the selection of either a linear or logarithmic amplification.

When the TMI-1b is operated in conjunction with the Panoramic Telemetering Subcarrier Deviation and Three Point Calibrator, Model TMC-1a, the swept-oscillator signal is obtained from the TMC-1a. The sawtooth voltage that modulates the TMC-1a reactance-tube circuit is obtained from the TMI-1b.

In addition to a swept oscillator, the TMC-1a includes crystal oscillators that provide marker signals, an input-signal amplifier and suitable sequence-controlling circuits.

The TMC-1a may be operated with the TMI-1b to present either upper- and lower-limit markers or to present a center marker.

When operated to present limit markers, the upper-and lower-limit markers are provided by separate crystal oscillators. The output of each oscillator is connected to a gate. The gates are alternately keyed at the rate of 2 cps. The keying square wave is obtained from a 4-cps blocking tube oscillator divided down to 2 cps by a binary divider.

When operated to present a center marker, the lower-limit marker is turned off and a proper center-frequency crystal replaces the upper-limit-frequency crystal. The gates are locked to pass only the center-frequency crystal frequency.

The crystal-frequency output from the gates is suitably shaped and then divided down by two or more of a chain of nine binary dividers. The front-panel control that selects the channel selects the crystals and a number of binary dividers appropriate to the selected channel. The output from the divider chain is controlled by the marker gate.

The sub-carrier oscillator signal connected to the TMC-1a input terminals is amplified. The output from this amplifier is controlled by the signal gate.

The marker gate and signal gate are alternately keyed by a 1-cps square wave that is derived by binary division of the output from the 2-cps binary divider.

In this way, when operated to present limit markers, the signal at the output of the TMC-1a consists of first the upper-limit marker (first 1/4 second), then the lower-limit marker (next 1/4 second) and finally the sub-carrier oscillator signal (last 1/2 second), thereby completing a cycle. When operated to present a center marker, the signal at the output of the TMC-1a consists

* Refer to Block Diagrams (Figures IV-2, IV-3, IV-4, IV-5) and Schematic Diagrams for supporting information.

of first the center-frequency marker (for a 1/2 second) and then the sub-carrier oscillator signal (for a 1/2 second), thereby completing a cycle. A pulse derived from the 2-cps binary divider is used to synchronize the TMI-1b sawtooth generator at a 2-cps rate. The marker output takes place during one TMI-1b beam sweep thereby providing marker pips. The telemetry-oscillator sub-carrier output takes place during the next beam sweep thereby resulting in the sub-carrier pips. When the sub-carrier signal output is being passed by the TMC-1a control circuits, a pulse derived from the binary-divider chain is injected into the TMI-1b video circuit, velocity modulating the marker pips to facilitate identification. The availability of the velocity modulation is controlled by the same binary divider that controls the signal and marker gates.

Setting the TMC-1a CHANNEL SELECTOR to the desired channel automatically selects the correct markers (both in terms of crystals and appropriate division), the swept-oscillator range and center frequency for the selected channel, as well as appropriate selectivity-control voltages for the TMI-1b.

When the TMC-1a is used by itself as a source of marker signals, the swept oscillator is inoperative and the gating circuits are appropriately locked to pass only the chosen marker signals (i.e., either upper limit, center frequency or lower limit).

IV-2. CIRCUIT DESCRIPTION, MODEL TMI-1b

a. INPUT CIRCUIT

The TMI-1b input circuit consists of an INPUT LEVEL STEP Control (S101), an input cathode follower (V101B), a 350-cps to 85-kc bandpass filter (FL101) and a phase splitter (V101A).

When the SWEEP RANGE SELECTOR switch (S104) is set on either LOGarithmic or LINear, a signal input to one of the TMI-1b INPUT connectors (J101, the front panel INPUT connector or J102, the type BNC INPUT connector on the rear of the chassis) is connected to the STEP INPUT LEVEL control (S101). When the SWEEP RANGE SELECTOR is set on CALibration, a signal input to the TMI-1b is connected to TMI-1b CALibration INPUT connector (J103) and from this point, by means of an interconnecting coaxial cable, the signal is connected to the TMC-1a input. The progress of the signal through the TMC-1a will be considered in Paragraph IV-4 below. When the TMI-1b SWEEP RANGE SELECTOR is set to CALibration, BNC connector J104 (CALibration OUTPUT) is connected to the STEP INPUT LEVEL control (S101). J104 is connected to the TMC-1a output by means of an interconnecting coaxial cable. In this way, the output signals from the TMC-1a are fed to the input of the TMI-1b.

The signal switching described above takes place in section S104D of the SWEEP RANGE SELECTOR. With normal interconnection of the TMI-1b and TMC-1a, it should be noted that because of this switching circuit, the TMC-1a input connectors are connected to the TMI-1b input connectors only when the TMI-1b SWEEP RANGE SELECTOR is on CALibration. For this reason it is normally preferable to connect the source of signals to the TMI-1b INPUT since a signal connected to the TMC-1a INPUT can be seen on the TMI-1b crt screen only when the TMI-1b SWEEP RANGE SELECTOR is on CALibration. Signals connected to the TMI-1b INPUT can be seen on all three positions of the SWEEP RANGE SELECTOR.

The STEP INPUT LEVEL control (S101) can provide a maximum of 60 db of attenuation of the input signal in 6-db steps.

The signal then passes through an input cathode follower (V101B) to a 350-to 85,000-cps bandpass filter (FL101) whose characteristic impedance is 1,000 ohms. This filter serves to attenuate frequencies outside the range of the equipment thereby minimizing spurious responses to such signals.

The output from the filter is connected to a phase splitter (V101A). The level of signal going to the linear amplifier is controlled by the CONTINUOUS INPUT LEVEL control (R116). A maximum of approximately 20 db of attenuation can be had.

Holding the "momentarily on" toggle switch FREQuency MARKERS (S108) to the ON position results in the injection into the cathode circuit of the phase splitter (V101A) of 350-cps, 5-kc, and 285-kc signals as well as harmonics of these signals, thereby providing 350-cps, 5-kc, and 85-kc marker pips as well as marker pips resulting from harmonics of 350 cps and 5 kc. The derivation of the markers is discussed in paragraph "b" below.

The outputs from the plate and cathode of the phase splitter (V101A) are coupled to the grids of V103 and V104 respectively. Swept oscillator voltage is connected to the grid of the oscillator buffer V102. The derivation of this voltage is discussed in paragraph "c" below.

b. FREQUENCY MARKERS

For calibration purposes, 350-cps, 5,000 cps and 85,000 cps marker pips are provided by means of switch S108, FREQuency MARKERS.

When the SWEEP RANGE SELECTOR is set on LINear or LOGarithmic, the FREQuency MARKERS switch is connected to B+ by switch section S104A and hence, when it is turned "ON" B+ is applied to V115 and V116. The 350-cps and 5,000-cps markers are provided by a bridge-T audio oscillator (V115). Tube section V115A provides the 5,000 cps marker signal while V115B provides the 350-cps signal. The 85,000 cps pip is provided by a crystal-controlled oscillator (V116). A 285-kc crystal is used. Since the 285 kc crystal frequency is the image of 85 kc (the i-f being 100 kc) a pip will result on the screen at 85 kc. The output of the three-marker generators is combined and injected in the cathode circuit of the phase splitter (V101A).

Since the markers are injected after the INPUT LEVEL controls, these controls have no effect on the marker level. The marker level can be changed by use of the SCALE MULTIPLIER switch or the SCALE SELECTOR switch (LIN-LOG amplitude).

c. SWEPT OSCILLATOR.

Swept-oscillator signal is coupled to the grid of the oscillator buffer (V102). The output of the oscillator buffer is coupled to the common cathode of the balanced modulator (V103, V104).

When the SWEEP RANGE SELECTOR is on CALibration, this signal is derived from the TMC-1a through connector J104 (CAL OSC INPUT). The derivation of this signal will be discussed in Paragraph IV-4 below. When the SWEEP RANGE SELECTOR is set on LINear or LOGarithmic the swept-oscillator signal is derived within the TMI-1b.

The TMI-1b swept oscillator (V110B) is of the Hartley type. Part of the tank circuit is a reactance tube (V110A) providing additional tuning capacitance for the oscillator. The value of this additional capacitance is determined by the grid voltage of the reactance tube. By appropriately varying this grid voltage, proper capacitance variation is obtained to provide the desired frequency variation of the swept oscillator.

When the SWEEP RANGE SELECTOR is on LOGarithmic an exponential wave shape is applied to the grid of the reactance tube. This causes the reactance-tube capacitance and thus the frequency of the swept oscillator to vary logarithmically. The exponential wave shape results from the charging characteristic of capacitor C178. A pulse derived by differentiation of the sawtooth at V120 triggers gas tube V118 thereby discharging capacitor C178. This completes one cycle of the exponential wave. Since the sawtooth repetition rate is one-cycle per second, the logarithmic frequency excursion of the swept oscillator will occur once per second. Two controls are used to adjust the exponential wave for proper frequency calibration, LOGarithmic 350 ~ (R263) and LOGarithmic 5 KC (R267). Variation of R263 affects the amplitude of the wave more than does R267 while R267 affects the slope of the wave more than does R263. Thus, LOGarithmic 350 ~ is used to adjust the frequency calibration of the low-frequency end of the band, while LOGarithmic 5 KC is used to adjust the frequency calibration of the middle of the band. There is a slight interaction between the two controls.

When the SWEEP RANGE SELECTOR is set on LINear, linear sawtooth is applied to the grid of the reactance tube. This causes the reactance-tube capacitance to vary in such a manner as to cause the frequency of the sweep oscillator to vary linearly. The sawtooth is derived from the blocking-tube oscillator (V119A) through the blocking-tube oscillator output cathode follower (V119B). From V119B the sawtooth is fed to the linear sweep cathode follower (V117A). The output of V117A is fed to the grid of the reactance tube. The CENTER FREQuency control (R254) determines the mean amplitude of the sawtooth applied to the reactance tube while the SWEEP WIDTH control (R177B) determines the total sawtooth amplitude. This determines the center frequency and width of the frequency excursion of the swept oscillator.

The switching of input to the grid of the reactance tube from exponential wave (for LOGarithmic operation) to linear sawtooth wave (for LINear operation) takes place in section S104A of the SWEEP RANGE SELECTOR.

d. BALANCED MODULATOR.

The outputs from the plate and cathode of the phase splitter (V101A) are coupled to the grids of V103 and V104 respectively. To compensate for component differences in the circuitry and amplitude differences between the two outputs from the phase splitter, two balancing controls are provided in the balanced modulator. COARSE BALANCE (R134B) is used to adjust the screen potential of V103 and V104. FINE BALANCE, effectively in parallel with COARSE BALANCE, provides a vernier adjustment of the screen potential of V103 and V104. Control adjustment changes the relative gain of V103 and V104 to compensate for inequalities in the circuitry and the phase splitter output amplitude. A third balancing control, PHASE BALANCE (R296), located in the plate circuit of V103 and V104 is used to correct phase inequalities that may exist. Sum and difference products appear at the output of the balanced modulator. Because the inputs to the balanced modulator are equal and 180 degrees

out of phase, the inputs to the balanced modulator are cancelled in the output.

e. INTERMEDIATE-FREQUENCY SECTION

The input to the intermediate-frequency section is a coil (L101) tuned to 100 kc, the intermediate frequency. This coil selects 100-kc difference products from the output of the balanced modulator. When the SWEEP RANGE SELECTOR is on LOGarithmic, the LOG GAIN control (R142) is used to adjust the impedance of L101 for standard sensitivity. When the SWEEP RANGE SELECTOR is on LINear or CALibration the LOG GAIN control is effectively a fixed resistor. This switching takes place in section S104B of the SWEEP RANGE SELECTOR.

The output of L101 is connected to the grid of the first i-f amplifier (V105) through the SCALE MULTIPLIER switch (S102). This switch can provide an additional 10-times attenuation of the input.

The i-f signal passes through a three-stage amplifier (V105, V106, V107, T101, T102, T103) that includes two identical 100-kc quartz-crystal filters (Y101, Y102).

The frequency resolution, or ability to separate individual frequency components, is a function of the instantaneous rate of frequency scan and the selectivity of the intermediate-frequency stages. Optimum resolution is obtained when a definite relationship exists between the two.

The presence of "ringing" on the trailing edge of the pip indicates that the equipment is close to or at optimum resolution. Assuming a fixed scanning velocity, the illustrations below show the changes in the screen presentations of a single frequency input when the i-f bandwidth is made progressively narrower.

In Figure IV-1, (a) and (b) the i-f bandwidth is broad for the particular scanning velocity. (c) shows the beginning of "ringing". The extent of "ringing" in (d) indicates optimum resolution. Note that the "ringing" pip closest to the signal pip extends to the baseline. As the i-f section is made narrower, excessive "ringing" widens the pip and the signal-pip amplitude decreases.

NOTE

At the high-frequency end of the screen the "ringing" at optimum resolution may not extend to the baseline because of limitations of the cathode-ray tube. In this case progressive narrowing of the i-f bandwidth will cause the "ringing" to approach the baseline, and then move away from it. When the "ringing" is closest to the baseline, the equipment is at optimum resolution.

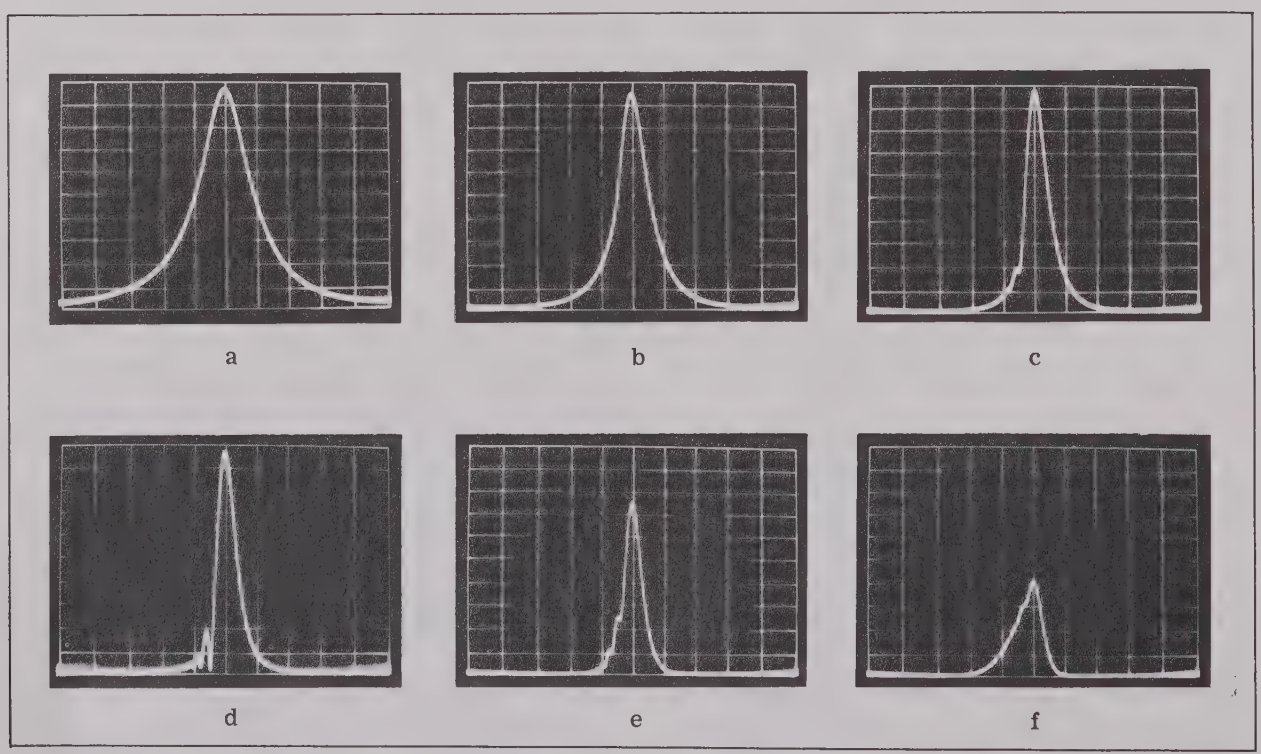

Figure IV-1. Ringing as an Indication of Optimum Resolution.

Since the repetition rate of scan is fixed (once per second when the SWEEP RANGE SELECTOR is on LOGarithmic or LINear and twice per second when on CALibration) the instantaneous scanning velocity depends only on the manner of the swept-oscillator excursion.

In the LOGarithmic position of the SWEEP RANGE SELECTOR the instantaneous rate of frequency scan is continuously varying, following a logarithmic function. The i-f selectivity varies in step with the electron-beam scan so as to maintain a substantially optimum relationship. The instantaneous rate of frequency scan is lower at the low frequency end of the beam scan and consequently a smaller i-f bandwidth is employed, whereas at the high end the bandwidth is increased to avoid excessive ringing accompanied by an unnecessary loss in resolution and effective gain. In the LINear position of the SWEEP RANGE SELECTOR the instantaneous rate of frequency scan is constant for each setting of the SWEEP WIDTH control. Thus, for optimum resolution, the i-f bandwidth is changed with changes of SWEEP WIDTH control setting.

The i-f bandwidth is automatically varied by changing the impedance of the crystal-filter load coils (L102, L103). This is accomplished by varying the tube impedance of the selectivity-control tubes (V112, V113), V112 being part of the load across L102 and V113 being part of the load across L103. The dynamic range of the control tubes is increased by connecting the two sections of each tube in cascode. SELECTIVITY EQUALIZER (R219) is used to balance the two control tubes.

When the SWEEP RANGE SELECTOR is on LOGarithmic, shaped sawtooth derived from the cathode of V119B is fed to the grids of the selectivity-control tubes (V112, V113) so as to vary the tube impedances in step with the sawtooth. In this way the i-f selectivity is automatically varied in step with the frequency scan to maintain approximately optimum resolution. LOG SELECTIVITY SWEEP (R274) controls the amplitude of sawtooth applied to the grids of the selectivity tubes and therefore controls the range of variation of selectivity. LOG SELECTIVITY ADJUST (R272) determines the bias on the grids of the selectivity tubes and therefore the average selectivity effect of the tubes.

When the SWEEP RANGE SELECTOR is on LINear, the grid bias of the selectivity control tubes is determined by the LIN SELECTIVITY control (R177A). This control is on the same shaft as the front panel SWEEP WIDTH control. By this means, the i-f selectivity is suitably varied with change in sweep width.

When the SWEEP RANGE SELECTOR is set on CALibration, proper selectivity-control-tube-biasing voltage is obtained from the TMC-1a.

In LOGarithmic operation, a shaped sawtooth is derived from the cathode of V119B and applied to the grid of the first two i-f amplifiers (V105, V106). The bias variation is such as to compensate for gain variation caused by the change in selectivity over the frequency-scanning range thereby resulting in a practically constant i-f gain over the frequency range of operation. The FLATNESS control (R277) controls applied voltage and is set for optimum flatness.

In LINear operation, the grid bias of V105 and V106 is kept at a constant voltage determined by the setting of LIN GAIN (R186), thereby maintaining a constant i-f gain. In CALibration operation i-f gain-controlling bias is derived from the TMC-1a.

f. DETECTOR AND VERTICAL AMPLIFIER

Following the i-f section is a detector (V108A) and a vertical amplifier (V108B). Part of the output from the detector can be fed back to the grid of the third i-f amplifier (V107) by setting the SCALE SELECTOR switch (S103) to LOGarithmic. Without feedback (S103 set to LINear) amplitude ratios as high as 10 to 1 can be seen on the crt screen. With the compression introduced by the feedback (S103 set to LOGarithmic) amplitude ratios as high as 100 to 1 (40 db) can be seen on the crt screen. The vertical output is connected to the vertical crt plates in push-pull, the output of V108B being connected to one of the crt vertical plates and the output from V109A (vertical-output tube) being connected to the other vertical plate.

When the SWEEP RANGE SELECTOR in on LINear or CALibration, switch section S104C introduces a video filter into the vertical-amplifier circuit. This VIDEO FILTER switch (S105) is used to provide filtering to reduce spurious beats that result when two signals are close in frequency. Two degrees of filtering are available: high (marked H) and low (marked L). In addition, the switch has an OUT position that removes the VIDEO FILTER from the circuit.

g. SAWTOOTH GENERATOR AND SWEEP CIRCUITS.

The sawtooth voltage is derived from a blocking-tube oscillator (V119A). When the SWEEP RANGE SELECTOR is set to LINear or LOGarithmic, the sawtooth frequency is determined by the setting of the 1 CYCLE SWEEP RATE control (R185) while in CALibration the rate is determined by the setting of the 2 CYCLE SWEEP

RATE control (R182). The switching from R185 to R182 is done in section S104C of the SWEEP RANGE SELECTOR. The two controls vary the time constant of the grid circuit of the blocking-tube oscillator and thereby vary the sawtooth rate. In CALibration operation, a 2-cps pulse is derived from the TMC-1a to synchronize the sawtooth generator. In CALibration operation the 2 CYC LINE SIZE control (R180) is used to control the sawtooth amplitude and thus the size of the crt baseline trace.

The sawtooth output of V119A (blocking-tube oscillator) is connected to the blocking tube oscillator output cathode follower (V119B) whose output is connected to the horizontal-output amplifiers (V120). The outputs of V120 are connected in push-pull to the horizontal-deflection plates of the crt. The LINE SIZE control varies the size of the baseline trace by varying the sawtooth input to V120B thereby varying the output of V120B. The trace position is varied by adjusting the average dc level of the output from V120B by means of the HORizontal POSition control. The 2 CYC LINE SIZE control is used to adjust the sawtooth input to V120 so that it is the same at the 2-cps sweep rate as it is at the 1-cps rate. Thus line size and position is the same for all three settings of SWEEP RANGE SELECTOR.

As indicated above, in addition to providing horizontal-deflection voltage the sawtooth generator provides sawtooth-derived voltages to:

1. Provide automatic selectivity control and i-f gain compensation in LOGarithmic scan.

2. Trigger V118 and thereby provide proper grid voltage on the reactance tube for LOGarithmic scan operation.

3. Provide proper grid voltage on the reactance tube for LINear scan operation.

The TMI-1b blocking-tube oscillator also provides sawtooth voltage for TMC-1a operation.

IV-3. CIRCUIT DESCRIPTION, MODEL TMP-1b

The TMP-1b furnishes all necessary power for the TMI-1b as follows:

+255-v dc regulated	- Pin L of J910
+1830-v dc	- Pin M of J910
+82-v dc	- Pin D of J910
6.3-v ac balanced	- Pins E-F of J910
6.3-v ac balanced	- Pins A B of J910
-87-v dc regulated	- Pin H of J910
6.3-v ac unbalanced	- Pins A-B of J909
-1650-v dc	- Pin A of J909

NOTE

Voltage is from pin to ground unless otherwise specified.

The power input to the TMP-1b is derived from a constant-voltage transformer that provides a stable source of 115-v, 60-cps power when connected to a 60-cps power source (95-125 v).

The +255-v dc is provided by a full-wave rectifier (V901). Filtering is introduced by L901 and C902 A and B. Regulation is accomplished by V902, V903, and V904. The voltage- regulator tube (V904) provides a reference voltage for the regulator-control tube (V903).

V903 serves as a dc amplifier that amplifies and feeds back to the grids of the series regulator (V902) any voltage change in the +255-volt line. This changes the series impedance of V902 so as to oppose the change in the +255-volt line. The VOLT ADJ. control (R916) is used to set the cathode voltage of V903 so that regulation produces a mean voltage of +255-v dc. The REG. ADJ. control (R908) adjusts the feedback for stable operation.

Negative high voltage for the cathode-ray tube (-1650-v dc) is provided by a half-wave selenium rectifier (CR903). Filtering is introduced by R920, C903, and C904. Positive high voltage for the post accelerator of the crt is provided by a half-wave selenium rectifier CR902. C907 provides filtering of this positive high voltage.

Direct current is used in certain critical tube filaments to reduce hum. This is provided by a bridge selenium rectifier (CR901). Filtering is introduced by R901 and C901A and B. The constant-voltage transformer provides power-line isolation for this supply.

V905 is a voltage regulator for the negative voltage supply derived in the TMI-1b from the negative high voltage.

IV-4. CIRCUIT DESCRIPTION, MODEL TMC-1a

NOTE

When the TMC-1a is used as an adjunct to the TMI-1b for telemetry-channel calibration, the two units must be properly interconnected. (See Chapter II), the TMI-1b SWEEP RANGE SELECTOR set to CALibration, and the TMC-1a OPERATION SELECTOR set to LIMITS CALibration or CENTER CALibration.

a. MARKER GENERATORS

The marker signals originate in two crystal-controlled oscillators (V410A, V411A). V410A is the crystal oscillator for the upper-limit and center-frequency markers. V411A is the crystal oscillator for the lower-limit marker. Three sets of crystals are available, 23 upper-limit crystals 18 center-frequency crystals, and 23 lower-limit crystals. This provides crystal pairs for the 18 standard ±7.5% deviation channels for the 5 optional ±15% deviation channels and a crystal for each center frequency of the channels, the optional channels having the same center frequency as 5 of the standard channels.

Setting the CHANNEL SELECTOR switch (S401) to a particular channel makes available the appropriate set of three crystals (upper, center, and lower) for that channel. Crystals are selected by switch sections S401A, S401B, and S401C.

When the OPERATION SELECTOR switch (S402) is set to CENTER CALibration, the center-frequency crystal is connected between the grid and plate of V410A, the upper-limit center-frequency oscillator. When the OPERATION SELECTOR is set to LIMITS CALibration, the upper-limit crystal is connected between the grid and plate of oscillator V410A. When the OPERATION SELECTOR is set to UPPER LIMIT, the upper-limit-frequency crystal is connected between the grid and plate of oscillator V410A. When the OPERATION SELECTOR is set to CENTER FREQuency, the center-frequency crystal is connected between the grid and plate of oscillator V410A. When the OPERATION SELECTOR is set to LOWER LIMIT, there is no crystal connected to oscillator V410A. The lower-limit crystal is connected between the grid and plate of the lower-limit oscillator (V411A) for all settings of the OPERATION SELECTOR. The selection of crystals within the triad selected by the CHANNEL SELECTOR takes place in section S402A of the OPERATION SELECTOR. The output of each oscillator is connected to a separate cathode-follower output tube (V410B for oscillator V410A and V411B for oscillator V411A).

The oscillator output is controlled by two gating tube sections (V425B, V425A). The cathode of V410B (oscillator cathode follower) is coupled to the grid of V425B (gate). The cathode of V411B (oscillator cathode follower) is coupled to the grid of V425A (gate).

The output from the crystal-oscillator cathode-follower output tubes, as controlled by the gates, is connected to the input of a chain of nine binary frequency dividers (Z401 to Z409) through a dual input tube V424. This crystal-oscillator output is suitably shaped to drive the dividers by L401.

When the OPERATION SELECTOR is on CENTER CALibration, switch section S402D provides a large negative grid bias for V425A thus cutting off the lower-limit gate. S402B removes B+ from lower-limit oscillator (V411A), thus stopping lower-limit signal. S402B also provides a large positive bias for the center-frequency gate (V425B) which is therefore able to conduct center-frequency signal from the oscillator cathode follower (V410B). The bias voltages supplied to the gates are sufficient to overwhelm the keying effect (see following paragraph) of the square-wave signal from Z413.

When the OPERATION SELECTOR is on LIMITS CALibration, a 2-cps square wave derived from Z413 is fed to the grid of V425B. Another 2-cps square wave, also derived from Z413 but 180 degrees out-of-phase with that fed to V425B, is fed to the grid of V425A. When the square wave is most positive the gate tube conducts thereby passing oscillator signal. When the square wave is least positive, the gate tube is cut-off by the fixed negative bias applied to the grid thereby stopping oscillator signal. Since the two square waves are 180 degrees out-of-phase, alternately the lower-limit-marker signal is passed by V425A (while the upper limit is blocked by V425B) and then the upper-limit-marker signal is passed by V425B (while the lower limit is blocked by V425A). Since the square wave repetiton rate is 2 cps, for 1/4 second the lower-limit signal is passed, then for the next 1/4 second the upper-limit signal is passed.

When the OPERATION SELECTOR is set to UPPER LIMIT or CENTER FREQuency, a positive bias derived from Z413 is applied to the grid of V425B (gate), thereby causing the gate to pass oscillator signal (either upper-limit or center-frequency depending on the crystal selected by S402A). When the OPERATION SELECTOR is on UPPER LIMIT or CENTER FREQuency, switch section S402B opens the B+ connection to the lower-limit oscillator (V411A) thereby stopping lower-limit signal.

When the OPERATION SELECTOR is on LOWER LIMIT, a positive bias derived from Z413 is applied to the grid of V425A (gate), thereby causing the gate to pass lower-limit oscillator signal. The action of switch section S402A is such that there is no crystal connected to upper-limit center-frequency oscillator. In addition, switch section S402F disconnects the B+ supply to the upper-limit center-frequency oscillator.

The crystal-oscillator output (as shaped by L401) is fed to Z401, the first of nine frequency dividers through a dual diode (V424). Output

from the divider chain can be picked off after division by 4, 8, 16, 32, 64, 128, 256, or 512. The correct divisor is automatically provided by switch section S401A when the CHANNEL SELECTOR switch (S401) is set for a particular channel.

The resultant output (which is now at the correct frequency for use in calibrating) is amplified and clipped by a limiter-amplifier (V414) and then fed to the marker amplifier and gate (V421B). (V421B is controlled by the marker-gate-control tube V421A.

Before considering the further flow of marker signal, the TMC-1a input signal will be traced through the TMC-1a.

b. INPUT CIRCUIT

As indicated in Paragraph IV-2 when the TMC-1a and TMI-1b are interconnected and their controls set for channel calibration (i.e., TMI-1b SWEEP RANGE SELECTOR set to CALibration and TMC-1a OPERATION SELECTOR set to LIMITS CALibration or CENTER CALibration), the TMI-1b and TMC-1a input connectors are interconnected.

Sub-carrier-oscillator input signals pass from the INPUT connectors to a signal amplifier and gate (V422A). Adjustable attenuation of the input signal is provided by the INPUT AMPLITUDE control (R683). The output from the signal amplifier (V422A) is controlled by a signal-gate control (V422B).

c. OUTPUT CIRCUIT

When the OPERATION SELECTOR is on LIMITS CALibration or CENTER CALibration, a 1-cps square wave derived from Z420 is fed to the grid of the signal-gate control (V422B). Another 1-cps square wave, also derived from Z420 but 180-degrees out-of-phase with that fed to V422B, is fed to the grid of the marker-gate control (V421A). When the square wave is most positive, the gate control conducts thereby cutting off the tube it controls. When the square wave is least positive, the gate control is cut-off by the fixed negative bias applied to the grid thereby allowing the tube it controls to conduct thus passing signal.

Since the two square waves are 180-degrees out-of-phase, alternately the marker amplifier (V421B) passes marker signals (while the input signal is blocked) and then the signal amplifier (V422A) passes input signal (while the marker signals are blocked). Since the square-wave repetition rate is 1 cps, for 1/2 second marker signals will be passed and for the next 1/2 second input signals will be passed. The BALANCE control (R676) is used to equalize the dc levels of V421 and V422 to minimize keying transients. When the OPERATION SELECTOR is set to LIMITS CALibration or CENTER CALibration, switch section S402C adds components to the grid circuit of V421B in order to reduce the marker-input amplitude to this tube. This reduces the marker-output amplitude from the TMC-1a to a level suitable for TMI-1b operation.

When the OPERATION SELECTOR is on other than LIMITS CALibration or CENTER CALibration bias voltages derived from Z420 results in the gate controls being conditioned to cut-off the signal amplifier (V422A) and to allow the marker amplifier (V421B) to conduct thereby passing marker signals only.

The output (either marker signal or alternately marker then input signal) is coupled to the composite-signal cathode follower (V419B), the output of which is connected to the TMC-1a OUTPUT connectors (J407 (front panel)), J404 and J413 (rear of chassis).

d. SWEPT OSCILLATOR

When the OPERATION SELECTOR is set to LIMITS CALibration or CENTER CALibration, switch section S402E connects the tubes in the swept-oscillator section (V415, V423) to B+. In the other positions of this switch, B+ is disconnected from these tubes.

The TMC-1a swept oscillator (V415A) is of the Hartley type. Part of the tank circuit is a reactance tube (V415B) of the Miller type providing additional tuning capacitance for the oscillator. The value of this additional capacitance is determined by the grid voltage of the reactance tube. Sawtooth voltage (derived from V119B of the TMI-1b) is applied to the reactance-tube grid thereby causing this capacitance to vary in step with the variation of sawtooth voltage. The maximum available sawtooth amplitude is adjusted with the SWEEP WIDTH LIMIT control (R853). For each setting of the CHANNEL SELECTOR switch, section S401F introduces a suitable cathode resistor for the reactance tube so as to adjust the bias for tube operation over the most linear portion of the tube characteristics. Switch section S401GH introduces coupling capacitance between the reactance tube and the oscillator coil such that the net capacitive effect of the reactance-tube circuit is appropriate for each channel. Switch section S401IJ introduces tuning capacitance across the oscillator coil such that the oscillator mean frequency is correct for each channel. Since the mean frequency and range of frequency is different for each channel, suitable tuning and coupling capacitances are introduced for each channel.

The output from the swept oscillator is amplified (oscillator amplifier, V423B) and passes through the oscillator cathode-follower output tube (V423A) to the TMC-1a OSCILLATOR OUTPUT connector (J405). An LC filter between the oscillator amplifier and the cathode follower is introduced to reduce the harmonic content and provide amplitude stability.

The front-panel controls are provided to vary the center frequency and the sweep width over a small range. The FREQ. ADJ. capacitor (C888) varies the tuning capacitance across the oscillator coil thereby varying the center frequency of the swept oscillator. The SWEEP WIDTH control (R855) is used to vary the amplitude of the sawtooth applied to the grid of the reactance tube thereby varying the frequency excursion of the swept oscillator.

e. VELOCITY MODULATION

A high-frequency pulse, obtained from the last of the chain of nine binary frequency dividers (Z409), is fed to the grid of V412B. Whether or not this pulse is passed by germanium diodes CR419 and CR420 to the VELOCITY MODULATION OUTPUT connector (J406) is determined by whether or not V412B is cut-off. A 1-cps square wave derived from Z420 is connected to the grid of V412B. When the square wave is negative, V412B is cut-off. Thus a suitable negative potential results on one end of CR419 thereby preventing the flow of velocity-modulation pulse. When the square wave is positive, V412B conducts. This results in the potential across the germanium diodes to be such as to allow the pulse to pass. The source of controlling square wave (Z420) is the same source that determines whether marker signals or input signals are being passed to the TMC-1a OUTPUT connector. See paragraph "c" above. The circuitry is such that the velocity modulation pulse is passed only when marker signal is passed rather than when the input signal is passed.

When the OPERATION SELECTOR is on other than LIMITS CALibration or CENTER CALibration a negative bias derived from Z420 results in V412B being cut-off thus preventing velocity-modulation pulses from passing to the TMI-1b.

f. COORDINATION CONTROL CIRCUITS

When the OPERATION SELECTOR is set to LIMITS CALibration or CENTER CALibration, B+ is applied to the plate of V412A which therefore functions as part of a 4-cps blocking-tube oscillator. When the OPERATION SELECTOR is set to UPPER LIMIT, CENTER FREQuency, or LOWER LIMIT, B+ is not connected to the plate of V412A and therefore no oscillation takes place. This switching takes place in switch section S402E. The SWEEP RATE control (R609) is used to set the grid time constant for 4-cps operation.

The 4-cps output from the blocking-tube oscillator is fed to a binary frequency divider (Z413). As explained above, the resultant 2-cps square-wave outputs are used to control the lower-limit-crystal-oscillator gate (V425A) and the upper-limit-crystal-oscillator gate (V425B).

In addition, the 2-cps output is shaped and fed to the synch-output cathode follower (V419A). From here it passes to Pin E of J408 hence to Pin E of TMI-1b connector J108 via an interconnecting cable. When the TMI-1b SWEEP RANGE SELECTOR is on CALibration this 2-cps pulse is connected (by means of switch section S104C) to the grid of the TMI-1b sawtooth-generating blocking-tube oscillator.

Output from the 2-cps frequency divider passes to a binary frequency divider (Z420). As explained above the resultant 1-cps square-wave outputs are used to control:

1. Marker-gate control (V421A)
2. Signal-gate control (V422B)
3. Velocity-modulation output (V412B)

When the OPERATION SELECTOR is set for other than LIMITS CALibration or CENTER CALibration, the TMC-1a blocking-tube oscillator is inoperative. Switch section S402C grounds either the grid of V413A or V413B (depending on switch setting) thereby producing bias to lock the crystal-oscillator gates properly. See paragraph "a" above.

Likewise, Z420 operates to produce bias that locks the output gates to pass only marker signals (see paragraph "c" above) and locks the velocity-modulation output tube (V412B) so as to prevent the flow of modulation pulses.

g. POWER-SUPPLY SECTION

All necessary power for the TMC-1a is supplied by the TMC-1a power supply section. This section furnishes -75-volts dc regulated by gas tube V418, a B+ supply regulated by gas tube V417, as well as an unregulated B+ supply. To reduce hum, the B+ supplies are provided with an LC filter while the B- supply is provided with an RC filter. There are two 6.3-volt ac filament supplies, one being part of the transformer that supplies B+ and B- (T402), the other being a separate filament transformer (T403).

For stability purposes the power input to the TMC-1a is supplied through a constant-voltage transformer.

h. OPERATION OF THE TMI-1b WHEN USED IN CONJUNCTION WITH THE TMC-1a.

The functioning of the TMI-1b when used in conjunction with the TMC-1a is essentially the same as when the TMI-1b SWEEP RANGE SELECTOR is set on LOGarithmic or LINear. The principal difference lies in the fact that in CALibration operation both the input signal and the swept-oscillator signals are provided by the TMC-1a.

When the two units are conditioned to operate together, input signals from telemetry sub-carrier oscillators are combined in the TMC-1a with appropriate marker signals and then fed to the input section of the TMI-1b. If the input signals are connected to one of the INPUT connectors of the TMI-1b then TMI-1b switch section S104D switches this input signal to the TMI-1b CAL INPUT connector (J103) which is connected by coaxial cable to the TMC-1a INPUT.

One of the OUTPUT connectors of the TMC-1a is connected to the TMI-1b CAL OUTPUT connector (J104) by coaxial cable. TMI-1b switch section S104D switches the signals from the TMC-1a to the STEP INPUT LEVEL control (S101). As explained previously, the output from the TMC-1a consists of sub-carrier-oscillator signals alternating with appropriate markers. From this point the input signals are handled by the TMI-1b in the manner as input signals in LINear or LOGarithmic operation.

As indicated in paragraph "f" above, when a 2-cps synchronizing pulse is applied to the TMI-1b sawtooth-generating blocking-tube oscillator, the TMI-1b 2 CYCLE SWEEP RATE control (R182) is used to set the time constant of the blocking tube-oscillator grid circuit so that stable, synchronized 2-cps sawtooth is obtained. The TMI-1b 2 CYC LINE SIZE control (R180) controls the sawtooth amplitude by determining the degree of charging of capacitor C182. This in conjunction with the TMI-1b LINE SIZE control determines the CAL operation crt line size. The 2-cps sawtooth is used (as is the 1-cps sawtooth in LINear and LOGarithmic operation) to cause horizontal crt deflection. In addition, a portion of the sawtooth at V119B passes to PIN F of J108 (TMI-1b) and from this point to Pin F of J408 (TMC-1a) by means of an interconnecting cable. This sawtooth causes the reactance-tube capacitance variation that provides the swept-oscillator signal. This swept oscillator signal (discussed in paragraph "d" above) passes to TMC-1a connector J405 and from this to J105 (TMI-1b CAL OSC INPUT) by means of a coaxial cable. From this point the swept-oscillator signal is injected into the TMI-1b oscillator buffer (V102) at the same point as is the swept-oscillator signal from the TMI-1b in LINear and LOGarithmic operation.

As indicated in paragraph "f" above, the coordination control circuit provides a velocity-modulation output only when the marker signals are passed (and stops the output of velocity-modulation pulse when subcarrier-oscillator signals are being passed). The pulses are injected into the vertical-output tube through TMI-1b connector J106 (VEL MOD INPUT) by means of a coaxial cable thereby velocity modulating the marker pip.

The TMC-1a switch section S401E determines the dc bias that is placed on the TMI-1b selectivity-control tubes and thereby determines the selectivity effect of these tubes. This bias passes through Pin D of J408 and J108. From J108 it is switched by switch section S104B to the grids of the selectivity control tubes. Since the selectivity requirement is different for each channel, a different bias is provided.

To provide suitable bias for the first two i-f amplifiers, a dc voltage is derived from the TMC-1a. The amplitude of this bias is determined by the setting of the CAL GAIN control (R688). It passes through Pin C of J408 and J108 by means of the interconnecting cable. From here it is applied to the grids of V105 and V106 by the action of switch section S104C of the TMI-1b SWEEP RANGE SELECTOR.

IV-5. CIRCUIT DESCRIPTION, MODEL TMC-1am

The TMC-1am operates exactly the same as the conventional TMC-1a in all positions of the OPERATION SELECTOR switch other than the AUTOmatic position. Therefore, in this section, only the circuitry related to the AUTOmatic position of the OPERATION SELECTOR will be discussed.

When the OPERATION SELECTOR S402 is switched to AUTOmatic, a single-pole single-throw switch S402G (located on the rear of S402) is closed. This switch completes the power circuit to the automatic-switching motor M401. In parallel with S402G is a resistor R701 and an indicating neon bulb I405 in series. This neon bulb will light when the power circuit to motor M401 is energized. Also in parallel with S402G is switch S405 which is mechanically linked to a driving dog on the motor shaft. If the dog is engaged in the sprocket on the CHANNEL SELECTOR, switch S405 is closed. Thus, if the OPERATION SELECTOR is turned to any position except AUTOmatic thereby opening S402G, S405 keeps the motor energized until the driving dog is disengaged from the sprocket thereby permitting manual rotation of the CHANNEL SELECTOR switch. When the OPERATION SELECTOR is rotated from AUTOmatic to any other position,

the high inertia of the motor may cause it to coast after the power is off so that the driving dog approaches the point where it will engage the sprocket. At this point S405 closes, energizing the power circuit and rotating the driving dog. When the driving dog is clear of the sprocket S405 will open and the motor will coast to a stop with the driving dog clear of the sprocket. Therefore, if the neon light goes out when the OPERATION SELECTOR switch is rotated from AUTOmatic, it is necessary to wait at least five seconds to allow the motor to stop before operating the CHANNEL SELECTOR. If the neon should light within the five-second period, the CHANNEL SELECTOR can be operated when the light goes out.

With the OPERATION SELECTOR in the AUTOmatic position, the UPPER LIMIT, CENTER FREQuency and LOWER LIMIT positions of S402C are connected to corresponding positions of S404A. The common of S402C is connected through the AUTOmatic position of S402C to the common of S404A thereby connecting S404A essentially in parallel with S402C. Thus, in the AUTOmatic position, motor driven rotation of S404A results in the same circuitry changes as does manual rotation of the OPERATION SELECTOR from UPPER LIMIT to CENTER FREQuency to LOWER LIMIT. Similarly, the common of S402A is connected through the AUTOmatic position of S402A to the common of S404B and with the OPERATION SELECTOR in the AUTOmatic position, the UPPER LIMIT and CENTER FREQuency positions of S402A are connected to corresponding positions of S404B. Thus in the AUTOmatic position motor driven rotation of S404B results in the same circuitry changes as does manual rotation of the OPERATION SELECTOR from UPPER LIMIT to CENTER FREQuency. However, the LOWER LIMIT position functions in a slightly different manner. When the OPERATION SELECTOR is set to LOWER LIMIT, the crystal is disconnected from the grid of V410A (S402A) and the B+ to the plate of V410A is removed, thereby making the upper-limit-center-frequency oscillator inoperative. When the OPERATION SELECTOR is on AUTOmatic and the position of S404 is such as to permit lower-limit signal, B+ to V410A is provided but the grid of V410A is grounded, thereby making the oscillator inoperative. Functionally both positions are the same. Note that switch section S402B always supplies B+ to V411A when the operation selector is set to AUTOmatic.

Mechanical drive for the automatic feature is provided by an internal shaded-pole squirrel-cage motor, M401. This motor has a speed reduction gear which provides a shaft rotation of approximately 20 sec/revolution. Directly driven by the shaft are switch wafers S404A and S404B, each wafer being a 3-position, 1-pole switch. Each position is on for 1/3 of the shaft rotation, or 6-2/3 seconds. Also connected to the motor shaft is a one-tooth driving dog which, once each revolution, engages a 24-tooth sprocket on the CHANNEL SELECTOR switch shaft, the 24-tooth sprocket corresponding to the 23 channel positions plus the OFF position. Therefore, once each shaft revolution the CHANNEL SELECTOR will be moved one position and each marker frequency for the particular channel (upper limit, center, and lower limit) will appear at the output. Each channel and the OFF position will be on for approximately 20 seconds (corresponding to one revolution of the motor shaft) and each marker frequency will be on for approximately 6 seconds (corresponding to one-third of a shaft rotation), there being approximately 2 seconds per channel taken by switching time.

Section S401K has been added to the CHANNEL SELECTOR in order that only one indicator be necessary to monitor the discriminator outputs. The indicator is connected to contact 24 of J420 and the remaining contacts are connected to the respective discriminator channel outputs in sequential order. As S401 rotates, the output of each channel discriminator is automatically switched to the monitoring indicator, in step with the output of the TMC-1am.

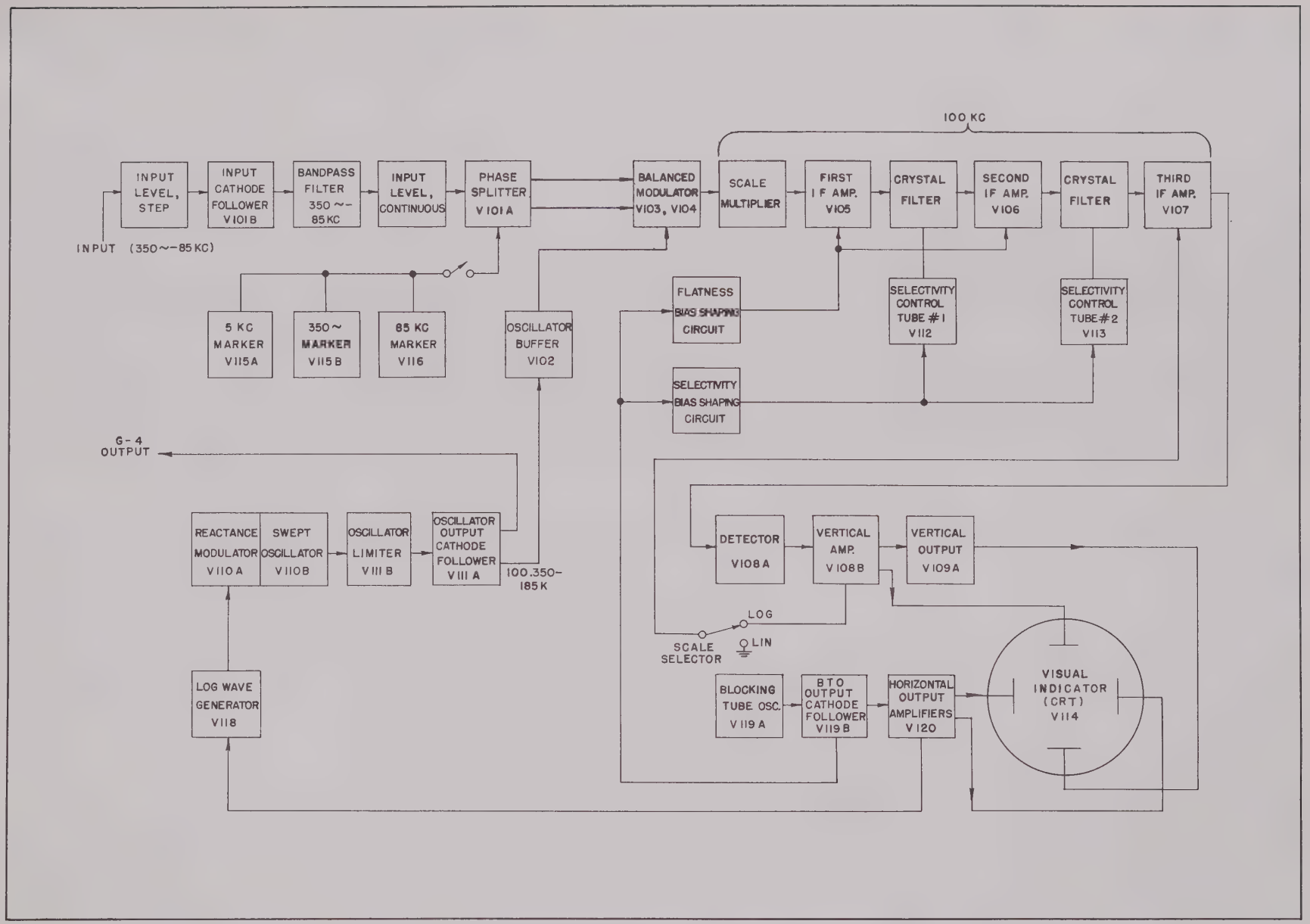

Figure IV-2. Block Diagram, Model TMI-1b, SWEEP RANGE SELECTOR Set on LOGarithmic.

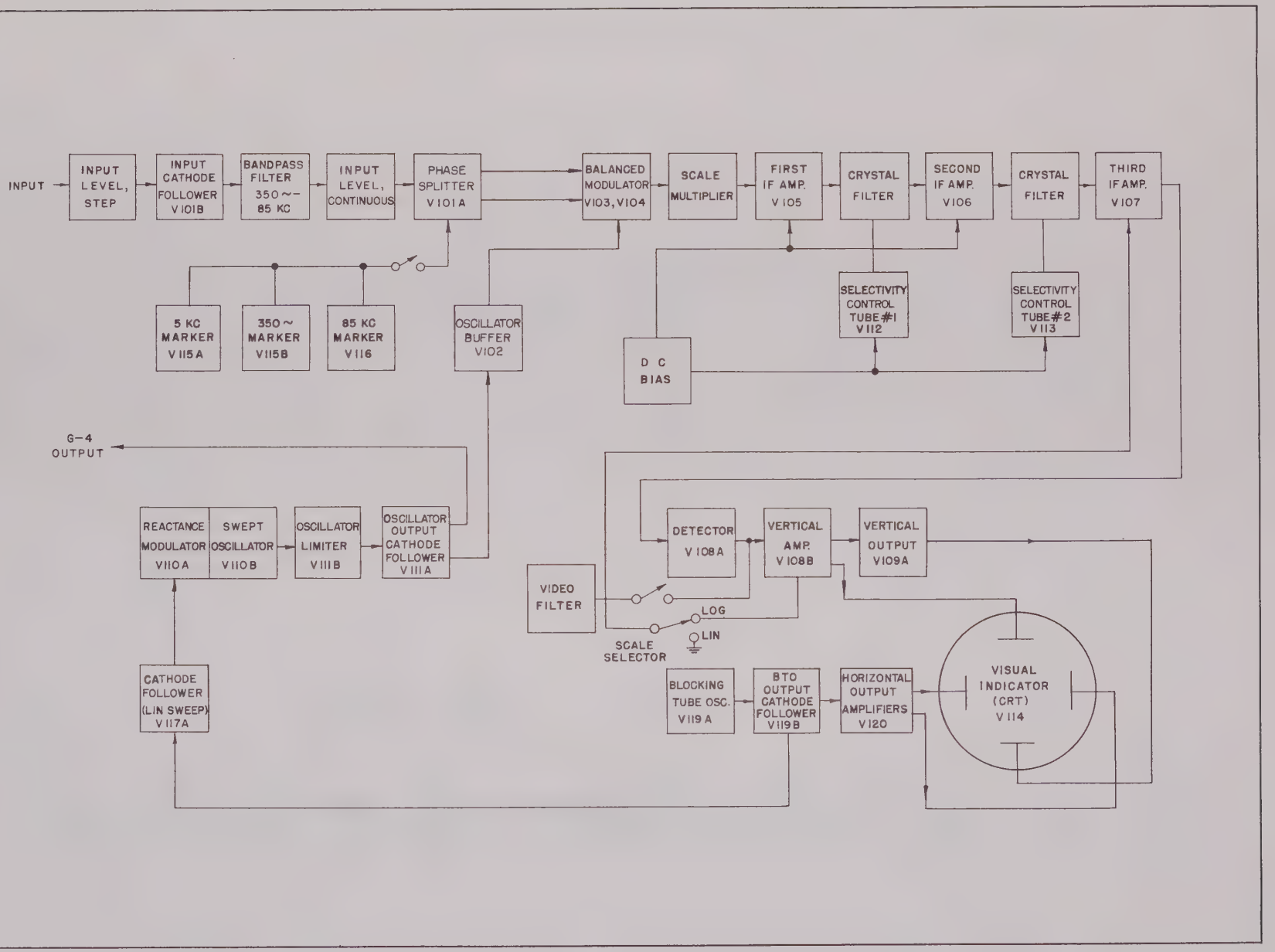

Figure IV-3. Block Diagram. Model TMI-1b. SWEEP RANGE SELECTOR Set on LINear.

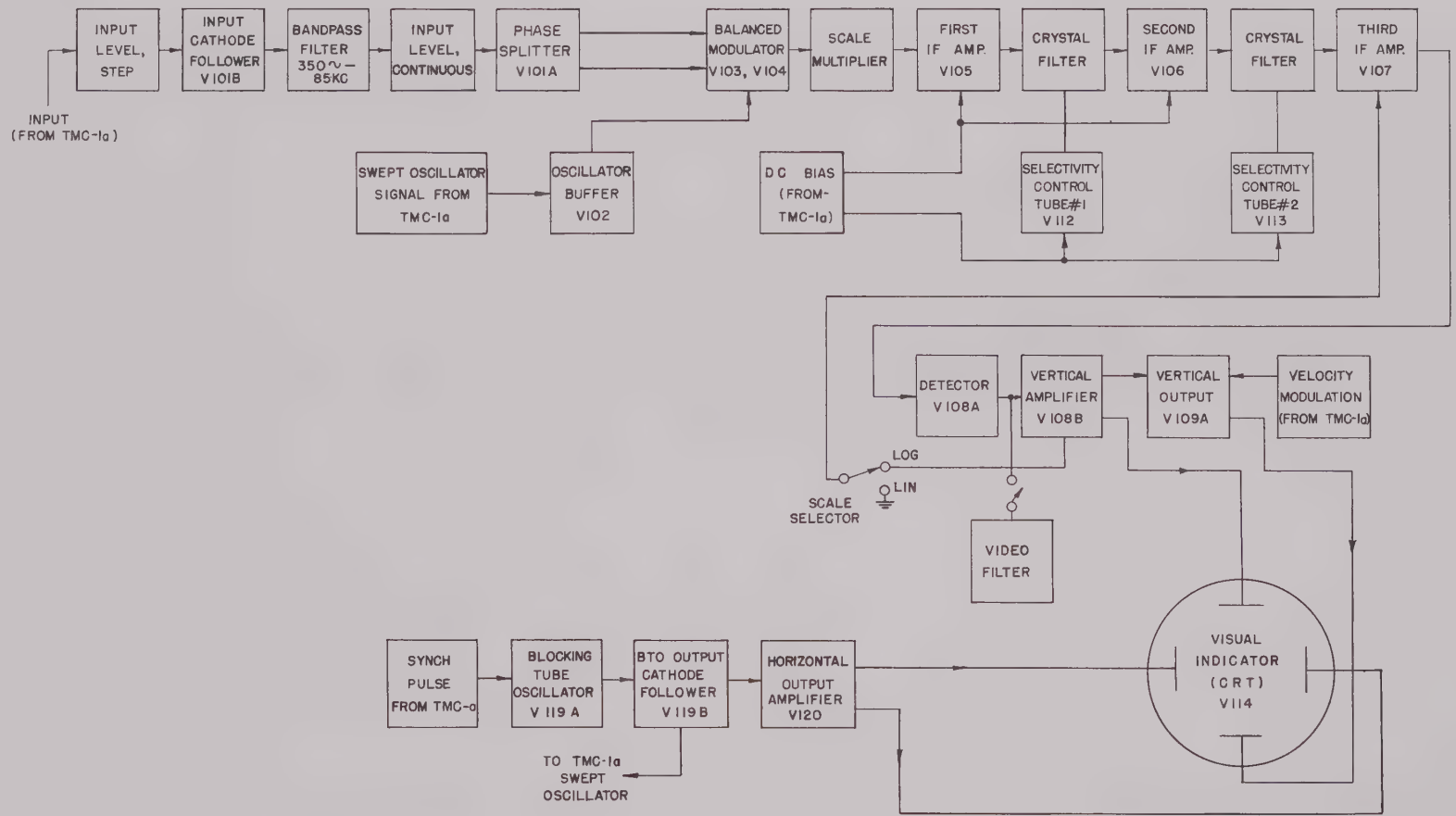

Figure IV-4. Block Diagram. Model TMI-1b. SWEEP RANGE SELECTOR Set on CALibration.

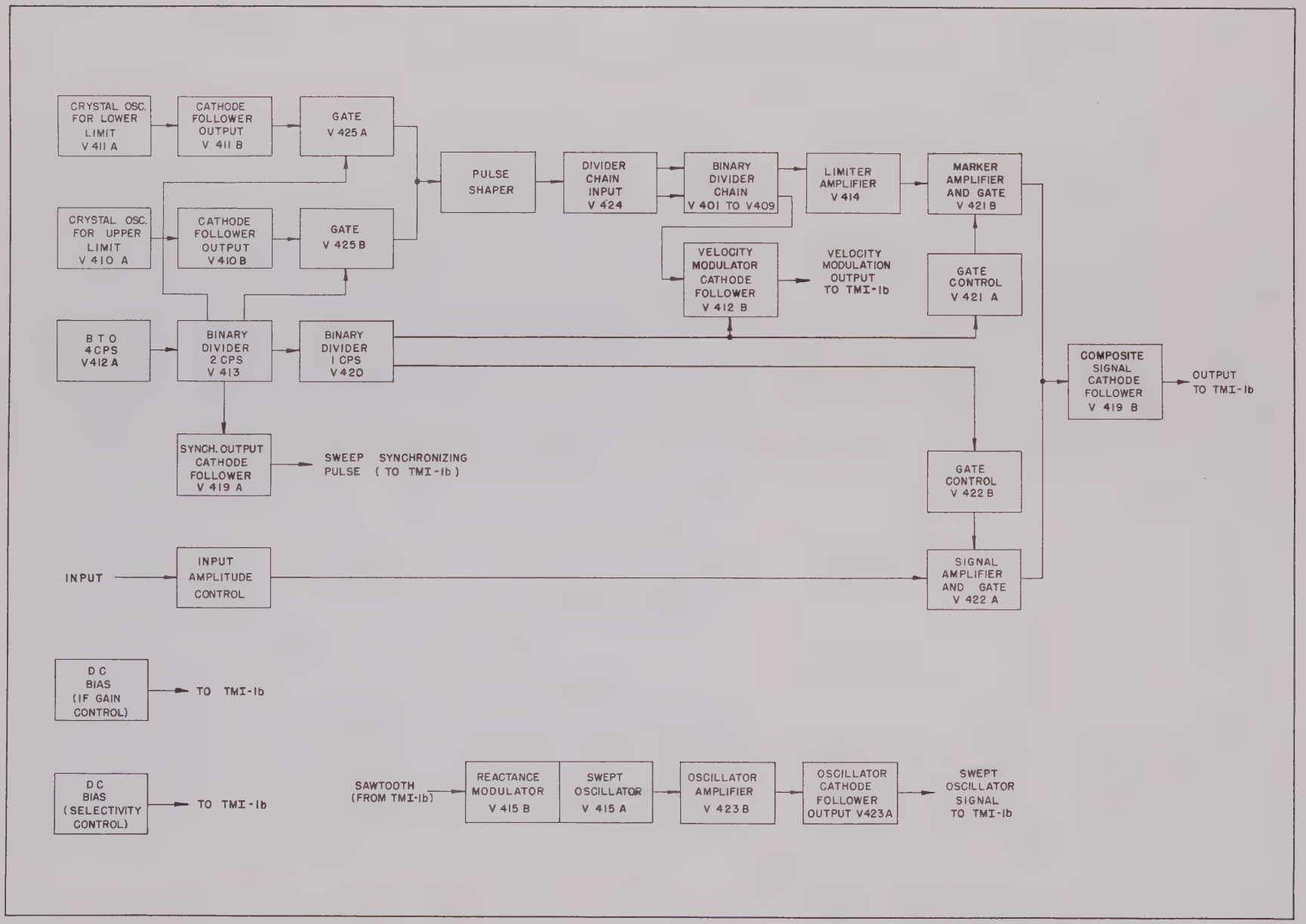
CRYSTAL OSC. FOR LOWER LIMIT V 411 A
CATHODE FOLLOWER OUTPUT V 411 B
GATE V 425 A
CRYSTAL OSC. FOR UPPER LIMIT V 410 A
CATHODE FOLLOWER OUTPUT V 410 B
GATE V 425 B
PULSE SHAPER
DIVIDER CHAIN INPUT V 424
BINARY DIVIDER CHAIN V 401 TO V 409
LIMITER AMPLIFIER V 414
MARKER AMPLIFIER AND GATE V 421 B
VELOCITY MODULATOR CATHODE FOLLOWER V 412 B
VELOCITY MODULATION OUTPUT TO TMI-1b
GATE CONTROL V 421 A
B T O 4 CPS V 412 A
BINARY DIVIDER 2 CPS V 413
BINARY DIVIDER 1 CPS V 420
COMPOSITE SIGNAL CATHODE FOLLOWER V 419 B
OUTPUT TO TMI-1b
SYNCH. OUTPUT CATHODE FOLLOWER V 419 A
SWEEP SYNCHRONIZING PULSE (TO TMI-1b)
GATE CONTROL V 422 B
INPUT
INPUT AMPLITUDE CONTROL
SIGNAL AMPLIFIER AND GATE V 422 A
D C BIAS (IF GAIN CONTROL)
TO TMI-1b
D C BIAS (SELECTIVITY CONTROL)
TO TMI-1b
SAWTOOTH (FROM TMI-1b)
REACTANCE MODULATOR V 415 B
SWEPT OSCILLATOR V 415 A
OSCILLATOR AMPLIFIER V 423 B
OSCILLATOR CATHODE FOLLOWER OUTPUT V423A
SWEPT OSCILLATOR SIGNAL TO TMI-1b

Figure IV-5. Block Diagram. Model TMC-1a. OPERATION SELECTOR Set on LIMITS CALibration.

CHAPTER V
SERVICE AND MAINTENANCE

This chapter is divided into five sections to facilitate its use in connection with adjustment, repair, or alignment of the equipments.

Section I contains a discussion of the semi-adjustable controls found on the chassis of the equipments.

Section 2 outlines the nature of the touch-up alignment that may become necessary because of the aging or replacement of any of the tubes used in the equipment.

Section 3 is a complete factory alignment for the Models TMP-1b, TMI-1b, and TMC-1a. It should only be used after touch-up techniques have been tried but have failed to yield the desired results.

Before attempting a complete alignment it is important to be sure that the difficulties that are being experienced are not caused by malfunctioning of tubes or other components.

Section 4 is a guide to trouble shooting. The principal types of troubles that may be encountered are listed. For each trouble, the likely causes are indicated.

Section 5 is a voltage and resistance chart to be used as an aid to trouble shooting.

V-1. SCREWDRIVER-ADJUST CONTROLS

The controls described in this section seldom require adjustment. For this reason they are

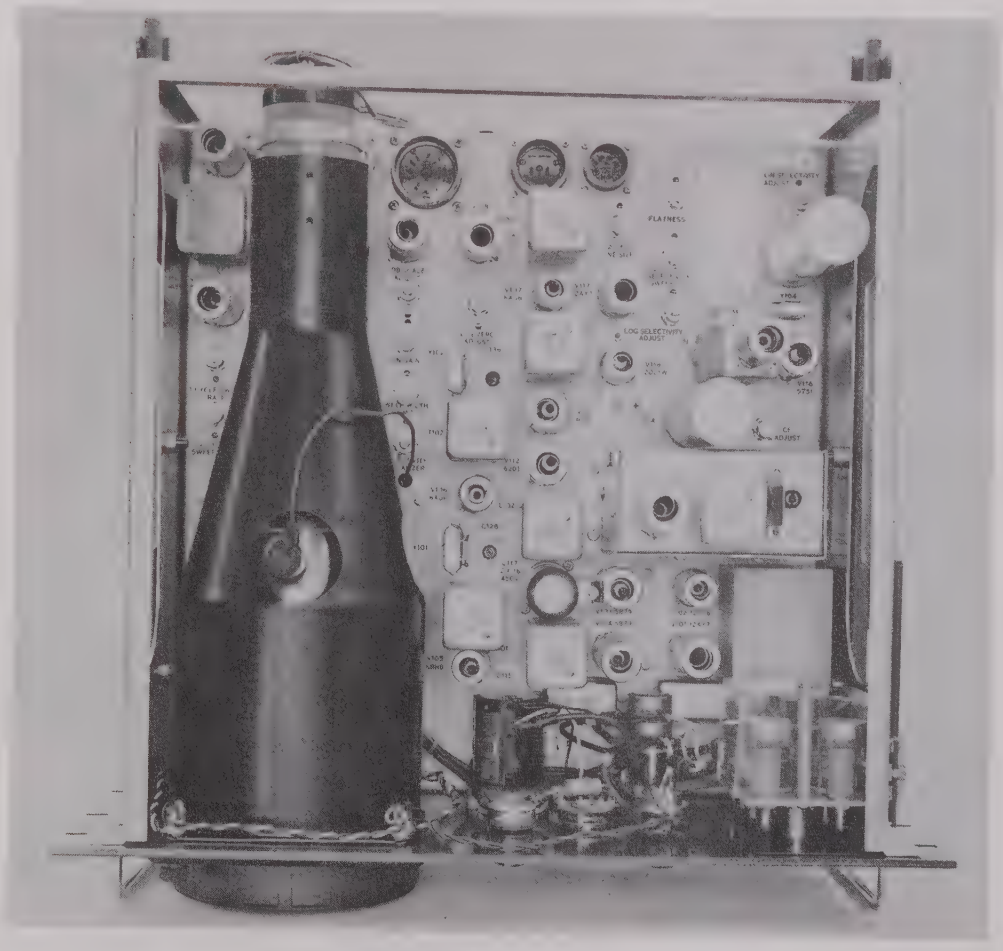

Figure V-1. Top Internal View, Model TMI-1b.

located on the chassis of the various equipments. They are normally used only in the course of service and maintenance.

a. MODEL TMI-1b. (See Figure V-1.)

1. 1 CYCLE SWEEP RATE. This control is used to adjust the blocking tube oscillator so as to provide a 1-cps crt beam rate when the SWEEP RANGE SELECTOR is set to LINear or LOGarithmic. It is usually necessary to accompany such adjustments with adjustment of HORizontal POSition and LINE SIZE. See paragraph V-3, b, 1.

2. 2 CYCLE SWEEP RATE, 2 CYC LINE SIZE. When the TMC-1a is used as an adjunct to the TMI-1b these controls are used to provide proper 2-cps beam rate, line size and position for CALibration operation. See paragraph V-3, c, 2.

3. LOG ZERO ADJUST, DB SCALE ADJUST. These controls are used to adjust the last i-f stage and the detector circuit to provide proper LOGarithmic amplitude calibration. See paragraph V-3, b, 7.

4. LOG GAIN. This control is used to adjust the i-f gain of the TMI-1b to provide standard sensitivity for LOGarithmic frequency operation. See paragraph V-3, b, 8.

5. LIN GAIN. This control is used to adjust the i-f gain of the TMI-1b to provide standard sensitivity for LINear frequency operation. See paragraph V-3, b, 8.

6. FLATNESS. This control is adjusted to provide equal-amplitude response throughout the range of LOGarithmic frequency operation.

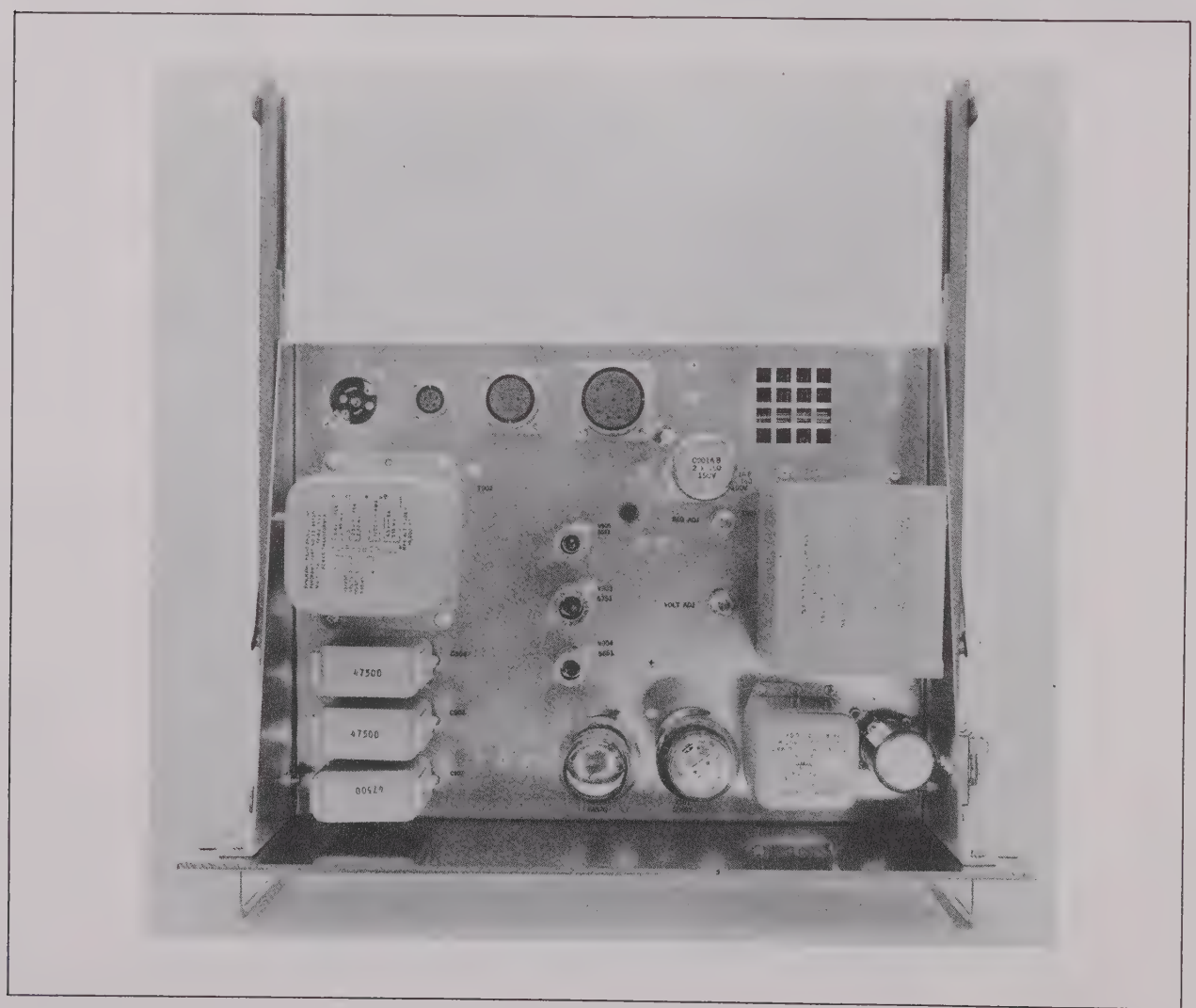

Figure V-2. Top Internal View, Model TMP-1b.

7. 350 CYC PAD. This control is used in conjunction with the front panel controls LOGarithmic 5KC and LOGarithmic 350 to provide proper LOGarithmic frequency calibration.

8. SWEEP WIDTH LIMIT. This control is used to set the maximum sweep width for LINear frequency operation.

9. SELECTIVITY EQUALIZER. This control is used to equalize the effect on selectivity (resolution) of the two selectivity-control tubes.

10. LOG SELECTIVITY SWEEP, LOG SELECTIVITY ADJUST. These two controls are used to provide proper resolution (selectivity) for LOGarithmic frequency operation. LOG SELECTIVITY ADJUST determines the average selectivity effect of the selectivity-control tubes while LOG SELECTIVITY SWEEP determines the range of the selectivity effect of the tubes.

11. LIN SELECTIVITY ADJUST. This control is used to provide approximately optimum resolution for LINear frequency operation.

12. C. F. ADJUST. This control is set at the factory and should not be used except in the course of a complete oscillator alignment. See paragraph V-3, b, 4.

b. MODEL TMP-1b. (See Figure V-2).

1. VOLT. ADJ. This control is used to set the B+ to 225-v dc.

2. REG. ADJ. This control is used to adjust the B+ regulating circuit for stable operation.

c. MODEL TMC-1a.

1. SWEEP RATE. This control is used to determine the rate of the TMC-1a blocking-tube oscillator. If it is adjusted, it will probably also be necessary to readjust the TMI-1b 2 CYCLE SWEEP RATE and 2 CYC LINE SIZE controls. See paragraph V-3, c, 2.

2. TRIGGER ADJ. This control is used to condition the input to the binary-divider chain to pass signals from the crystal oscillators. The method of adjustment is given in paragraph V-3, c, 3.

3. CAL GAIN. This control is used to adjust the i-f stages of the TMI-1b for an appropriate standard sensitivity for CALibration operation. See paragraph V-3, c, 7.

4. SWEEP WIDTH LIMIT. This control is used to adjust the maximum sweep width that may be obtained with the front panel SWEEP WIDTH control. It may require adjustment if V119 of the TMI-1b is changed. (See Section V-2a). See paragraph V-3, c, 4, for the use of this control in a complete alignment of the swept oscillator.

5. BALANCE. This control is used to balance switching transients. It is set in accordance with paragraph V-3, c, 6.

V-2. TOUCH-UP ALIGNMENT

This section indicates the adjustments that may be required when tubes age or are changed. The chart indicates what to look for. It is not intended to imply that any or all of the adjustments will have to be made. For details concerning adjustments refer to Paragraphs V-1 and V-3.

a. MODEL TMI-1b.

Tube	Adjustments
V101	LOG GAIN, LIN GAIN, CAL GAIN*
V102	LOG GAIN, LIN GAIN, CAL GAIN*
V103** V104**	LOG GAIN, LIN GAIN, CAL GAIN*
V105	FLATNESS, LOG GAIN, LIN GAIN, CAL GAIN*, T101, C120
V106	C128, L102, T102, FLATNESS, LOG GAIN, LIN GAIN, CAL GAIN*
V107	C136, L103, T103, LOG GAIN, LIN GAIN, CAL GAIN*, LOG ZERO ADJUST, DB SCALE ADJUST
V108	LOG ZERO ADJUST, DB SCALE ADJUST, VERTical POSition, LOG GAIN, LIN GAIN, CAL GAIN*
V109	VERTical POSition, LOG GAIN, LIN GAIN, CAL GAIN*
V110	Oscillator alignment, Recalibration of CENTER FREQuency and SWEEP WIDTH Dials and crt screens
V111	LOG GAIN, LIN GAIN, CAL GAIN*
V112** V113**	LOG GAIN, LIN GAIN, CAL GAIN*, FLATNESS, LIN SELECT ADJ, SELECTIVITY EQUALIZER, LOG SELECTIVITY ADJUST, LOG SELECTIVITY SWEEP

continued

* In TMC-1a
** Replace in pairs

Tube	Adjustments
V114	FOCUS, BRILLIANCE, ASTIGmatism, HORizontal POSition, LINE SIZE, VERT POS, LOG GAIN, LIN GAIN, CAL GAIN*, DB SCALE ADJUST, LOG ZERO ADJUST In CAL OPERATION: 2 CYC LINE SIZE, 2 CYC SWEEP RATE Note: It may be necessary to recalibrate the crt screens
V115	Check markers (350 cps and 5 kc)
V116	None
V117	SWEEP WIDTH and CENTER FREQuency Dials and SWEEP WIDTH LIMIT
V118	350 CYC PAD, LOGarithmic 350~, LOGarithmic 5 KC
V119	1 CYC SWEEP RATE, HORizontal POSition, LINE SIZE, FLATNESS, LOG SELECTIVITY SWEEP, SWEEP WIDTH Dial, SWEEP WIDTH LIMIT In CAL OPERATION: 2 CYC LINE SIZE, 2 CYC SWEEP RATE. Note: If the change in sawtooth amplitude is sufficient to change CAL sweep width to a degree that is not tolerable, adjust SWEEP WIDTH LIMIT* to compensate for the change.
V120	LINE SIZE, HORizontal POSition

b. MODEL TMP-1b

V901	VOLT. ADJ.
V902	VOLT. ADJ.
V903	VOLT. ADJ. REG. ADJ.
V904	VOLT ADJ.
CR902, CR903	FOCUS, BRILLIANCE, ASTIGmatism, LINE SIZE Note: Possibly other adjustments listed for V114
V905	None

c. MODEL TMC-1a

V401	TRIGGER ADJ.

* In TMC-1a

Tube	Adjustments
V402-V409	None
V410, V411	TRIGGER ADJ.
V412	SWEEP RATE, 2 CYC LINE SIZE (TMI-1b), 2 CYCLE SWEEP RATE (TMI-1b)
V413	None
V414	None
V415	SWEEP WIDTH LIMIT, L402 These controls affect all channels. Note: It is preferable to try another tube.
V416	None
V417	None
V418	None
V419	2 CYC LINE SIZE (TMI-1b), 2 CYCLE SWEEP RATE (TMI-1b)
V420	None
V421	BALANCE
V422	BALANCE
V423	CAL. GAIN
V424	None
V425	TRIGGER ADJ.

V-3. COMPLETE ALIGNMENT PROCEDURE

This is a complete factory alignment and should only be used after touch-up alignment techniques have been tried and have failed to yield satisfactory results. As a result of a complete alignment it may be necessary to construct error charts for, or recalibrate, the crt calibrated screens and the CENTER FREQuency Dial.

The following equipment is required.

1. Two well calibrated signal generators, one with a 350-cps to 100-kc range (with an accurate internal or external level indicator), the other with a 50-cps to 10-kc range.*

* For TMI-1b and TMP-1b alignment.

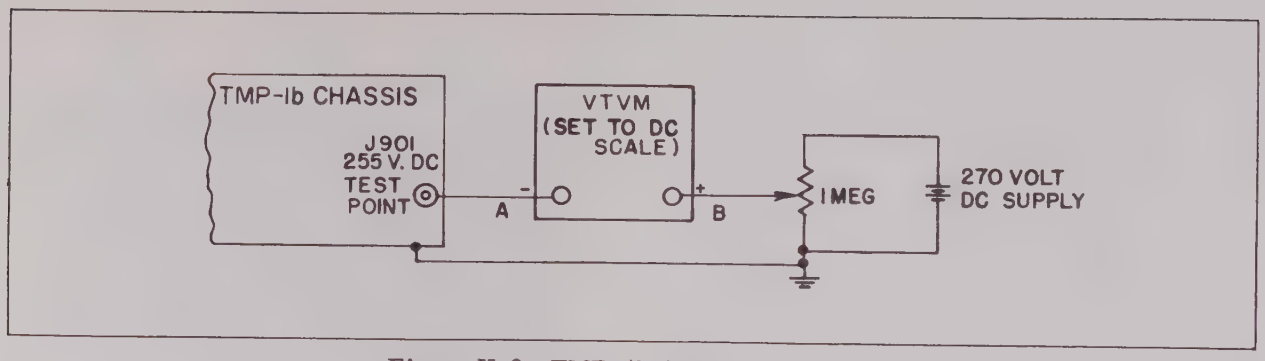

Figure V-3. TMP-1b Alignment Circuit

2. A 270-v dc supply with provision for output amplitude adjustment in the neighborhood of 255 volts.*

3. A -22 1/2 volt or greater dc bias supply (battery satisfactory).*

4. A vacuum-tube voltmeter.

5. Two precision Decade Resistors. 0 to 510 K ohms.**

6. Frequency Indicating Counter capable of measuring frequencies up to 500 kc.**

NOTE

If a counter is not available, an accurate signal generator and an oscilloscope may be used to provide Lissajous patterns for frequency indication.

Before starting a complete factory alignment allow at least a one hour warm up period for the TMI-1b and TMP-1b and at least a half-hour warm-up period for the TMC-1a. Note particularly that the baseline trace may take approximately one hour to reach its operating size.

a. MODEL TMP-1b.

1. With the TMP-1b interconnected to the TMI-1b for normal operation (including the constant-voltage transformer) adjust the +255-v supply with the aid of the following circuit. Instead of the 270-volt supply with the 1-megohm variable resistor, any suitable regulated dc supply that has an adjustable output can be used.

2. Before connecting the circuit shown in Figure V-3:

(a) Adjust the output from the external dc supply so that it is +255 v (i.e., point B to ground to be +255 v).

(b) Set VOLT ADJ. (R916) so that the voltage from J901 (255 V. DC TEST POINT) to ground is +255-v dc.

3. Now connect the circuit shown in Figure V-3. Set the meter to the lowest dc range. The following procedure will be more conveniently performed if the meter zero is in the center of the dial.

4. Connect a 10-k ohm, 10-watt resistor from J901 to ground. Adjust REG. ADJ. (R908) so that the VTVM reads a positive voltage less than 0.1 v.

5. Remove the 10-k ohm resistor. Adjust VOLT. ADJ. (R916) so that the VTVM reads zero.

6. Repeat steps 4 and 5 until when the 10-k ohm resistor is connected, the meter remains at zero or rises slightly in reading (but does not fall), i.e., the voltage from point "A" on Figure V-3 to ground is either 255 volts or just under 255-v dc (but no greater than 255 v) and when the 10-k ohm resistor is removed the meter reads zero, i.e., the voltage from point "A" to ground is 255-v dc.

b. MODEL TMI-1b

1. Baseline Adjustment

(a) Adjust the FOCUS, ASTIGmatism, BRILLIANCE, and VERTical POSition controls in accordance with Chapter II-4a steps 1 to 5.

(b) Check the sweep rate of the crt beam for 19 to 21 sweeps in 20 seconds. If the sweep rate is not within these limits, adjust 1 CYCLE SWEEP RATE (R185) until the rate is within the specified limits.

(c) Adjust the LINE SIZE and HORizontal POSition controls in accordance with Chapter III, Paragraph 1.a.5. (See Figure III-3 for an illustration of correct size and position.)

* For TMI-1b and TMP-1b alignment.
** For TMC-1a alignment.

(d) Repeat steps (b) and (c) until the rate, line size, and positioning are correct.

2. I-F Alignment

NOTE

It may be necessary to adjust the input signal levels to keep the baseline trace on the screen.

All coils are tunable from the top of the chassis. It is necessary to open the adjustable dust cover on the top of the coil shield can. Adjustments of the top core are made by inserting the end of the (supplied) alignment tool that has a metal pin through the dust cover of the coil can and engaging the slots in the hollow top core stud with the pin of the tool. Bottom core adjustments are made by passing the screwdriver tip end of the tool through the hollow top core until the tip of the tool engages the screwdriver slot in the solid bottom core.

(a) Set the SWEEP RANGE SELECTOR to LINear. Set the SCALE SELECTOR to LINear. Set the SCALE MULTIPLIER to X1. Set the CENTER FREQuency control to 20 KC. Set LOG ZERO ADJUST to mid-rotation.

(b) Turn the LOG GAIN and LIN GAIN controls completely clockwise.

(c) Connect the negative side of a -22.5 volts dc or more supply (battery or otherwise) to the intersection of R223, R217, R218. The positive side is to be connected to chassis ground.

(d) Couple a 100-kc signal through a 0.01 uf capacitor to pin 1 of V107. The 0.01 uf capacitor should also be used in the following steps. Adjust the top and bottom cores of T103 for a maximum baseline rise.

(e) Connect the 100-kc signal to pin 1 of V106. Adjust the bottom core of T102 for a maximum baseline rise.

(f) Connect the 100-kc signal to pin 1 of V105. Adjust the bottom core of T101 for a maximum baseline rise.

(g) Connect the 100-kc signal to pin 1 of V103. Adjust the bottom core of L101 for a maximum baseline rise.

3. Adjustment of the Crystal-Filter Circuits

NOTE

If it is necessary to replace crystals, the replacement crystals should be obtained in matched pairs from Panoramic Electronics, Inc. In the following procedure the negative 22.5 volt source is connected to the intersection of R223, R217 and R218 as outlined in paragraph 2 (c) above.

(a) Set the SWEEP RANGE SELECTOR to LINear. Set the SCALE MULTIPLIER to X10.* Set the SCALE SELECTOR to LINear.

(b) Set the SWEEP WIDTH control to maximum (20 KC).

(c) Connect a 20-kc signal to the INPUT terminals of the TMI-1b.

(d) Set the CENTER FREQuency control so that the 20-kc pip is at the center of the screen. At this point two pips may be present on the screen, the sharper one being the response of the crystals. The other pip is the result of misalignment of i-f coils due to a difference in frequency between the signal generator and the crystals. Retune the top and bottom cores of T103 and bottom core of T102, T101, and L101 for maximum height of the sharp pip. After this is done only one pip should appear. Adjust LIN GAIN so that with the INPUT LEVEL controls at maximum clockwise setting a 20-millivolt signal will result in a full scale pip.

(e) Adjust the SWEEP WIDTH control, while maintaining the pip at the center of the screen with the CENTER FREQuency control, so that the base of the pip occupies approximately 1/3 of the baseline.

(f) Short out crystal Y101. Use a short length of wire so as to minimize pick-up. Adjust the INPUT LEVEL controls such that it will be possible to increase the gain of the equipment 18 db with the INPUT LEVEL controls (INPUT LEVEL, STEP set three steps (18 db) counterclockwise from 60 marking). Set the signal-generator output level for a full-scale pip.

(g) Trim C136 to remove the rejection slot. (See Figure V-4). Increase the gain of the TMI-1b db by use of the INPUT LEVEL controls while continuing to trim C136 for removal of the rejection slot and best pip symmetry. If necessary, readjust the SWEEP WIDTH control so that the sides of the pip continue to go into the baseline.

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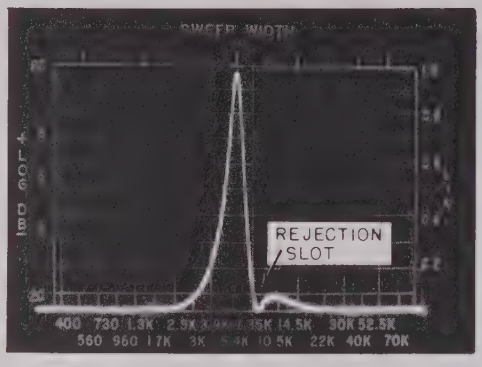
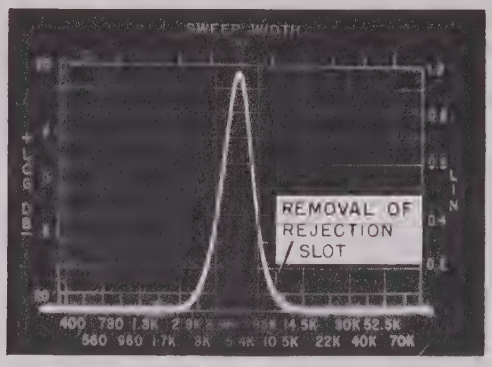
* This is important so as to avoid possible oscillation in the i-f section.



A. Illustration of Rejection Slot.



B. Illustration of Complete Rejection Slot Removal.

Figure V-4. Crystal Rejection Slot Removal.

(h) Reduce the gain with the INPUT LEVEL controls so that a full scale pip is presented.

(i) Adjust the top and bottom cores of L103 for minimum deflection and broadest pip, adjusting the INPUT LEVEL and SWEEP WIDTH controls to keep the sides of the pip visible. If the pip moves across the screen, keep it centered by use of the CENTER FREQ. control or by shifting the input frequency. Note that when the cores are correctly set, a condition of minimum height and broadest pip will be achieved. As the cores are moved away from their correct position, the pip will increase in amplitude, become narrower, and shift horizontally.

(j) Repeat steps (g) to (i).

(k) Remove short across crystal Y101.

(l) Short out crystal Y102 using a short length of wire.

(m) If necessary, readjust the INPUT level controls for a full scale pip.

(n) Repeat g to j using C128 and the top and bottom cores of L102 in place of C136 and L103.

(o) Remove the short across crystal Y102.

(p) Remove the -22 1/2-volt dc supply inserted in step (c) of paragraph 2 (the I-F Alignment). In the following steps maintain a full scale pip.

(q) Turn the LIN SELECTIVITY ADJUST control (R174) completely counterclockwise. Set the SWEEP WIDTH control to 5 KC maintaining the pip in the center of the screen with the CENTER FREQuency control. Set the SCALE MULTIPLIER to X1.

NOTE

At this point it is advisable to read the discussion on "ringing" in Chapter IV Paragraph 2.e.

(r) Turn the LIN SELECTIVITY ADJUST control clockwise until ringing is just noted on the trailing (left) side of the pip. Be sure that the VIDEO FILTER switch is set to OUT.

(s) Retune L101, T101, T102 and T103 for maximum pip height as necessary.

(t) Short out one crystal (Y101, Y102) at a time, noting the amount of ringing present with each crystal.

(u) Adjust SELECTIVITY EQUALIZER (R219) so that the ringing is the same for each crystal by itself.

NOTE

When each crystal is considered by itself, there may be either no ringing or too much ringing. If this is the case, readjust LIN SELECTIVITY ADJUST for some suitable degree of ringing for each crystal and then proceed to adjust SELECTIVITY EQUALIZER.

(v) With both crystals (Y101, Y102) installed, set the SWEEP WIDTH control to 20

KC. Adjust LIN SELECTIVITY ADJUST for optimum resolution.

(w) Turn the SWEEP WIDTH control throughout its range and note the degree of ringing present. Adjust LIN SELECTIVITY ADJUST for best ringing at 20 -kc sweep width. Select the value of R176 for best ringing in the center of the range of the SWEEP WIDTH control. (Increasing the value of R176 will increase the degree of ringing at the center of the SWEEP WIDTH range with respect to the ringing at the maximum setting of the control). The LIN SELECTIVITY ADJUST control should be set in conjunction with the chosen value of R176 for best ringing throughout the range of SWEEP WIDTH control.

4. Oscillator Alignment

(a) Set the following controls to the positions listed below.

SCALE SELECTOR	LINear
SCALE MULTIPLIER	X1
C. F. ADJUST (S106)	Position 6 of this 11 position switch
LOG SELECTIVITY ADJUST (R272)	Full counter-clockwise
LOGarithmic 350~	Center of rotational range
VIDEO FILTER	OUT
SWEEP WIDTH	20 KC
CENTER FREQUENCY	0

(b) Check line size, horizontal position, and sweep rate.

(c) Disconnect the external generator from the TMI-1b. The "zero" pip should appear on the screen. Reduce SWEEP WIDTH to minimum, keeping the "zero" pip at the center of the screen with the LINear 350~ control. If the LINear 350~ control has insufficient range, it will be necessary to adjust the C. F. ADJUST control. Turn C. F. ADJUST one step clockwise. Repeat the adjustment of the LINear 350~. If it has less range than before, rotate C. F. ADJUST two steps counterclockwise and repeat the adjustment of LINear 350~. If LINear 350~ had insufficient range in the original position of C. F. ADJUST, a setting of C. F. ADJUST either one step clockwise or counterclockwise should be sufficient.

(d) Set SWEEP RANGE SELECTOR to LOGarithmic. Connect an 85-kc signal to the INPUT connector of the TMI-1b.

(e) Adjust the core of the oscillator coil (L104) so that the 85-kc pip falls under the 85 KC screen marker.

(f) Change the input signal frequency to 5 kc.

(g) Adjust LOGarithmic 5 KC (R267) until the 5-kc pip falls under the 5 KC screen marker. Note that to obtain this result it may be necessary to adjust 350 CYC PAD (R264).

(h) With the 5-kc input signal, adjust LOG SELECTIVITY ADJUST (R272) for optimum ringing.

(i) Adjust LOGarithmic GAIN (R142) so that with the INPUT LEVEL controls at the maximum-clockwise setting, a 2-millivolt signal will result in a full-scale pip. Reduce the input frequency until either the pip is at the left edge of the screen calibration or the input frequency is 350 cps, whichever happens first. If a baseline rise interferes with the signal pip, it will be necessary to balance the equipment. See Chapter III, Paragraph 1.a.4.

(j) Adjust LOG SELECTIVITY SWEEP (R274) (and LOG SELECTIVITY ADJUST if LOG SELECTIVITY SWEEP has insufficient range) for optimum resolution.

(k) Adjust the 350 CYC PAD so that a 350-cps signal pip falls under the 350 CPS screen marker.

(l). Working back and forth between both controls, adjust the 350 CYC PAD and the LOGarithmic 5 KC control so that a 5-kc pip falls under the 5 KC screen marker and a 350-cps pip falls under the 350 CPS screen marker.

(m) Change the input frequency to 85 kc. If necessary, readjust L104 to obtain coincidence between the pip and the 85 KC screen marker.

(n) If it was necessary to change the setting of L104, then readjust LOGarithmic 5 KC and 350 CYC PAD for correct frequency calibration.

(o) Repeat steps (m) and (n) until the three points (350 CPS, 5 KC and 85 KC) are correct.

5. Adjusting LOGarithmic Scan Resolution and Flatness.

(a) Connect a 5-kc signal to the INPUT.

(b) Adjust LOG SELECTIVITY ADJUST for optimum resolution.

(c) Change the input signal to 400 cps.

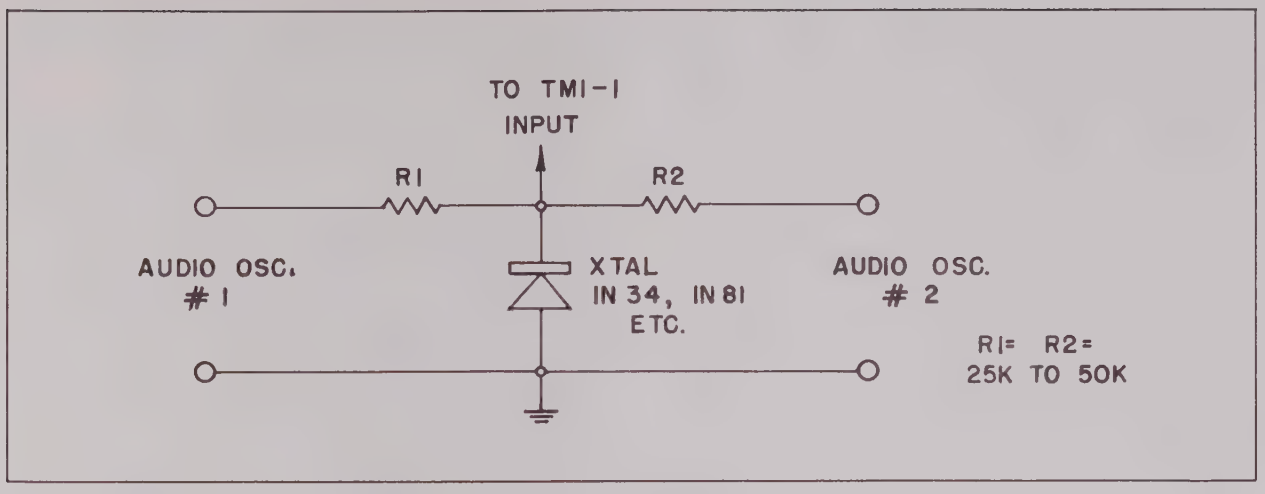


Figure V-5. Linear Alignment Test Network.

(d) Adjust LOG SELECTIVITY SWEEP for optimum resolution.

(e) Repeat steps (a) to (d) until optimum resolution is obtained at both 400 cps and 5 kc.

(f) Note: If FL101 has been replaced, see paragraph V-3, b, 10, i. Vary the input frequency from 350 cps to 85 kc keeping the input-signal amplitude constant. Adjust the FLATNESS control (R277) for the most constant pip amplitude over the frequency range that is possible. Slight readjustment of LOG SELECTIVITY ADJUST and LOG SELECTIVITY SWEEP may be of aid in obtaining FLATNESS. Readjust cautiously to avoid adverse resolution effects.

6. LIN Frequency Alignment.

CAUTION

THE LOG SWEEP ALIGNMENT MUST BE CORRECT BEFORE ATTEMPTING THE LIN SWEEP ALIGNMENT. IN PERFORMING THE LIN ALIGNMENT, DO NOT CHANGE L104 OR THE LOG ALIGNMENT WILL BE UPSET.

(a) Check the SWEEP WIDTH Dial calibrations as follows:

(1) Set up the isolating and mixing network, shown in Figure V-5, through which two signal generators are connected to the INPUT of the TMI-1b.

(2) Set audio oscillator #1 to 20 KC and audio oscillator #2 to 10 KC.

(3) Set the SWEEP WIDTH Dial to 20 KC. Set the SCALE SELECTOR SWITCH to LOGarithmic.

(4) Adjust the CENTER FREQuency Dial for a centered 20-kc pip.

NOTE

Three pips should be visible. The center pip is 20 kc and the two side pips (which should fall under the end most (±5) divisions of the LINear frequency calibration at the top of the crt screen) are ±10 kc of 20 kc, i.e., 20 kc and the sum and difference products of the mixing between 20 kc and 10 kc.

(5) If the ±10-kc pips do not fall under the ±5 LINear frequency calibration marks at the top of the crt screen, adjust SWEEP WIDTH LIMIT (R258) until they do.

(6) Vary the frequency of audio oscillator 2 (and the setting of the SWEEP WIDTH control appropriately) to check all calibration points on the SWEEP WIDTH control. If necessary, adjust the setting of the CENTER FREQuency control to keep the center pip at the center of the screen.

(7) Turn off audio oscillator #2.

(8) Set the SWEEP WIDTH control to 20 KC.

(9) Adjust LIN SELECTIVITY ADJUST for optimum resolution.

(10) Vary the SWEEP WIDTH control through its range noting the ringing. Adjust

LIN SELECTIVITY ADJUST for best resolution through the range of the SWEEP WIDTH control.

(b) Check the CENTER FREQuency Dial calibrations as follows:

(1) Remove the mixing network introduced in step (a) (1).

(2) Connect a 350-cps input signal to the TMI-1b INPUT.

(3) Set the CENTER FREQuency Dial to the dot indicating 350 cps. Reduce the sweep width while maintaining the right-hand 350-cps pip (there may be 3 pips; one 350-cps pip on each side of a possible zero pip) under the zero of the LINear frequency crt screen calibration with the LINear 350 control (R253) until minimum sweep width is reached.

(4) Vary the input frequency between 350 cps and 70 kc checking each calibration point on the CENTER FREQuency Dial.

NOTE

To facilitate the finding of a pip an increased sweep width should be used. For the final accurate check of a calibration point, minimum sweep width should be used.

(c) If the calibrations of one or both of the dials is incorrect either construct an error chart or calibrate new dials using the procedure given for checking the dial calibrations.

7. Adjusting the LIN-LOG Amplitude Controls.

(a) With SWEEP RANGE SELECTOR set on LOGarithmic and the SCALE SELECTOR (S103) set to LINear, SCALE MULTIPLIER on X1, connect a 500-cps signal of sufficient amplitude to provide a full scale deflection to the TMI-1b INPUT.

(b) Set the SCALE SELECTOR to LOGarithmic.

(c) Adjust LOG ZERO ADJUST (R154) for a 0 DB (half scale) pip height on the crt-screen DB amplitude scale.

(d) Increase the input-signal amplitude 10 times.

(e) Adjust DB SCALE ADJUST (R158) for a full-scale pip.

(f) Repeat steps (c) through (e) until the LOGarithmic amplitude scale is correct.

8. Adjusting Standard Sensitivity

(a) Set the following controls to the listed positions.

SCALE MULTIPLIER	X1
INPUT LEVEL, STEP	60
INPUT LEVEL, CONTINUOUS	1 division less than MAXimum
SCALE SELECTOR	LINear
BALANCE CONTROLS	Best Balance
SWEEP WIDTH	5 KC
CENTER FREQ	5 KC
SWEEP RANGE SELECTOR	LOGarithmic

(b) Connect a 2-millivolt, 5-kc signal to the INPUT of the TMI-1b.

(c) Set LOG GAIN (R142) for full-scale pip.

(d) Set the SWEEP RANGE SELECTOR to LINear.

(e) Set LIN GAIN (R186) for a full scale pip.*

9. Checking the Internal Markers

(a) Set the SWEEP RANGE SELECTOR to LINear, the SWEEP WIDTH Dial to minimum, and the SCALE SELECTOR to LINear.

(b) Connect an accurate 350-cps signal to the TMI-1b INPUT.

(c) Set the CENTER FREQuency Dial for a centered 350-cps pip.

(d) Hold the FREQuency MARKERS switch to ON. A "zero beat" condition indicates that the 350-cps marker is correct. When the two signals (external and internal) are close in frequency, there will be one pip whose amplitude varies. When the two signals are the same in frequency (zero beat) the amplitude variation will cease.

(e) Change the input frequency to 5 kc.

(f) Set the CENTER FREQuency Dial for a centered 5-kc pip. The correctness of internal 5-kc marker is indicated by zero beat.

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* If the TMC-1a is functioning correctly, it is appropriate at this point to adjust CAL GAIN (in the TMC-1a). See paragraph V-3.c.7.

(g) Turn the SWEEP RANGE SELECTOR to LOGarithmic.

(h) Change the input frequency to 85 kc. The correctness of the 85-kc internal marker is indicated when the internal and external signal pips overlay.

(i) If 350 cps is in error, adjust the value of fixed resistor R240. Increasing R240 will reduce the frequency and vice versa. If 5 kc is in error, adjust the valve of fixed capacitor C164. Increasing C164 will reduce the frequency and vice versa.

10. TMI-1b Factory Selected Components

(a) R161. This resistor is used to provide proper range for the VERTical POSition control. If VERTical POSition has insufficient range, set it to center of its rotational range. Correct vertical position should then be obtained by changing the value of R161.

(b) R286. This resistor is used to provide proper range for the HORizontal POSition control. If HORizontal POSition has insufficient range, set it to the center of its rotational range. Correct horizontal position should then be obtained by changing the value of R286.

(c) R240. This resistor is used to correct the frequency of the 350-cycle FREQ. MARKER oscillator. See paragraph 9 above.

(d) C164. This capacitor is used to correct the frequency of the 5-kc FREQ. MARKER oscillator. See paragraph 9 above.

(e) R176. This resistor is used in conjunction with LIN SELECTIVITY ADJUST to provide best resolution over the range of the SWEEP WIDTH control. See paragraph 3, step (w) above.

(f) R295, R297. These resistors are used to obtain proper range of the PHASE BALANCE control. If the PHASE BALANCE control does not achieve balance but tends toward an unbalance-pip null in the counterclockwise position, increase the value of R295 to achieve proper range of the PHASE BALANCE control. If there is an unbalance-pip null when the PHASE BALANCE control is in the clockwise position, decrease the value of R295 to achieve proper range of the PHASE BALANCE control. If the above procedure does not obtain the proper balance point, then the value of R297 should be selected to bring the zero pip down approximately to the baseline.

(g) C120. The capacitor is selected to improve the accuracy of the SCALE MULTIPLIER. Set the SCALE MULTIPLIER to X1, and the SCALE SELECTOR to LINear. Adjust the signal generator to give a full-scale pip on the screen.

Set SCALE MULTIPLIER to X10. Increase signal-generator output ten times (20 db). Select C120 for a full-scale pip.

(h) C125 - This capacitor is selected to improve amplitude flatness over the range of the SWEEP WIDTH control. Set SWEEP RANGE SELECTOR to LINear, SCALE SELECTOR to LINear, CENTER FREQUENCY to 20 KC, SWEEP WIDTH to 20 KC. Adjust signal generator for a full scale 20-kc signal pip. Reduce SWEEP WIDTH to 100 CPS. If the pip amplitude has changed more than 30%, C125 can be reduced to increase amplitude or increased to decrease amplitude, at 100-cps sweep width.

(i) R114. - If the input bandpass filter (FL101) is changed, this resistor is used (if necessary) to provide proper input-section flatness. To determine whether or not adjustment is necessary, connect a signal generator (350 cps to 85 kc) to the grid (pin 2) of V101 through a 0.1 uf capacitor. With the SWEEP RANGE SELECTOR set to LOGarithmic, vary the frequency from 350 cps to 85 kc keeping the amplitude at the grid constant. Note the pip height through the frequency range. Connect the signal generator to the INPUT connector and repeat. If there is a difference in amplitude-versus-frequency response, adjust the value of R114. If the amplitudes at the ends of frequency range are high with respect to the center, decrease the value of R114. If the ends of the frequency range are low with respect to the center, increase the value of R114.

(j) R247. - If the amplitude of the 85-kc marker is improper, select the proper value of R247. With the SCALE SELECTOR set to LOGarithmic and SCALE MULTIPLIER set to X1, a -4 db 85-kc marker pip should result. If the amplitude is low, decrease R247. If the amplitude is high, increase R247.

c. MODEL TMC-1a

1. Preliminary Adjustments

(a) Interconnect the TMC-1a, the TMI-1b, and the TMP-1b in accordance with paragraph II-3.

(b) Adjust the TMC-1a, TMI-1b and TMP-1b in accordance with paragraphs II-4b (1) to II-4b(6).

2. Sweep Rate

(a) Adjust the TMC-1a SWEEP RATE control (R609) so that the TMC-1a front panel

SWEEP RATE indicator (I404) flashes 18 to 22 times in 20 seconds.

(b) Adjust the TMI-1b 2 CYCLE SWEEP RATE control (R182) for a synchronous TMI-1b beam rate of 36 to 44 times in 20 seconds with the right edge of the baseline trace beginning as near as possible to the same point as it does on LIN and LOG operation (in the middle of the "0" of the LIN amplitude screen calibration). Note that lack of synchronism is indicated by instability of the trace.

(c) Adjust the TMI-1b 2 CYCLE LINE SIZE control (R180) so that the left end of the baseline trace falls under the left edge of the "2" on the -20 db of the LOG amplitude scale.

(d) Repeat steps 2 and 3 until the rate is synchronized and within the specified limits and the size and position of the baseline trace are correct.

3. Trigger Adjust

NOTE

Only if the TRIGGER ADJ. (R593) is properly adjusted will both of the CHANNEL OUTPUT lamps (I401, I402) be lit. Failure of one of the lamps to light or flickering of the lamps indicates failure of the equipment to deliver correct output signals. The fact that both lamps are lit means that some output signal, but not necessarily the correct output signal, is available at the output of the chain of nine binary dividers.

(a) Set TRIGGER ADJ. so that the correct output frequency is obtained with the OPERATION SELECTOR set to UPPER LIMIT and the CHANNEL SELECTOR on "D" and also with the OPERATION SELECTOR set to LOWER LIMIT and the CHANNEL SELECTOR on "6". Note that if one of the lamps is not lit, then a considerable change in the control setting is required. If the lamps are flickering, only a small change is required.

(b) The setting of TRIGGER ADJ should be suitable for all settings of OPERATION SELECTOR and CHANNEL SELECTOR. However, the output frequency should be checked for each channel with the OPERATION SELECTOR set to UPPER LIMIT, CENTER FREQuency, and LOWER LIMIT. If any position requires a readjustment of TRIGGER ADJ., each prior position must be rechecked and if necessary redetermined in order to find a setting that is proper for all channels and the UPPER LIMIT, CENTER FREQuency, and LOWER LIMIT positions of OPERATION SELECTOR. Note that if TRIGGER ADJ. is proper for these three positions of OPERATION SELECTOR, it will also be proper for LIMITS CALibration and CENTER CALibration.

4. Swept Oscillator Alignment

NOTE

There are four principal factors involved in the alignment of the TMC-1a swept oscillator.

The oscillator coil
The oscillator-tuning capacitors
SWEEP WIDTH LIMIT control
The oscillator-linearity resistors

Because of the fact that there is interaction among the several factors, it is important to follow the orderly procedure outlined below even when seeming shortcuts present themselves.

Because of the time and care required, a complete realignment of the swept oscillator should be avoided if possible. If it is attempted, it should be done only by experienced personnel.

(a) Preliminary Adjustments

(1) Be sure that the TMI-1b, TMC-1a and TMP-1b are interconnected as outlined in paragraph II-3.

(2) Set the TMI-1b front-panel controls as follows:

SWEEP RANGE SELECTOR	CALibration
SCALE MULTIPLIER	X10
SCALE SELECTOR	LINear
INPUT LEVEL, STEP	60
INPUT LEVEL, CONTINUOUS	1 division less than MAXimum
VIDEO FILTER	OUT

(3) Set the TMC-1a front-panel controls as follows:

OPERATION SELECTOR	CENTER CALibration
CHANNEL SELECTOR	18
INPUT AMPLITUDE	completely clockwise
FREQUENCY ADJUST.	Knob marker pointing to top of panel
SWEEP WIDTH	Center of rotational range

(4) Set the TMC-1a SWEEP WIDTH LIMIT chassis control to midrange. Set CAL GAIN to mid-range.

(b) Alignment

(1) Connect the Frequency Indicating Counter to J405 and measure the mean frequency of the oscillator. Note that the measurement of a swept signal is made. However, for the purpose of preliminary adjustment the accuracy under this circumstance is sufficient.

NOTE

Prior to the factory alignment the equipment does not contain the factory-selected resistors used to provide proper selectivity. (R801, R802, and R803 associated with switch section S401E). The factory-selected resistors used to provide proper swept-oscillator linearity (R825 to R847 associated with switch section S401F) are also not yet included. R804 to R823 are sub-miniature variable resistors built into the equipment. Two sets of decade resistors are used during the course of the alignment to provide a suitable resistance value for the factory selected resistors. However, in the case of field maintenance all resistors are in place. They may not be correct in terms of the requirements of the realignment. Final adjustment may then be made in accordance with section 5 below. Linearity resistors should be determined as the alignment proceeds. When results obtained during alignment indicate the need for a value change, the resistor in the set should be adjusted if variable or removed and a Decade Resistor substituted. Two sets of decade resistors may be required, one for linearity resistor determination and one for selectivity resistor determination. When needed, the Linearity Decade Resistor should be placed between pin "S" of the linearity terminal board and ground (see figure V-6). When needed for R801, R802, and R803 (which is rarely), the Selectivity Decade Resistor should be placed between pin "S" of the selectivity terminal board and ground (see figure V-6). The Decade Resistors should be connected only if the factory-selected resistor in question has been removed. If alignment is being done and the factory-selected resistor is in place, the Decade Resistor must be disconnected since the Decade Resistor would be in parallel with the resistor.

(2) Set the Selectivity Decade Resistor to approximately 4.7 K and the Linearity Decade Resistor to approximately 820 K.

NOTE

The following oscillator coil adjustments are extremely critical at low frequencies.

(3) Adjust the oscillator coil (L402) until the counter reads approximately 170 kc, i.e., the center frequency of channel 18 (70 kc) plus the TMI-1b intermediate frequency (100 kc). Clockwise rotation of the core of L402 decreases the oscillator frequency while counterclockwise rotation increases the oscillator frequency. If a marker pip is on the screen, increasing the oscillator frequency will cause the pip to move to the left. Decreasing the oscillator frequency will cause the pip to move to the right.

(4) When the Counter indicates approximately 170 kc, a pip should appear on the TMI-1b screen. If no pip appears, check gain and selectivity settings. Adjust L402 until the pip is in the center of the screen.

(5) Set OPERATION SELECTOR to LIMITS CALibration. Two pips should appear on the screen. Adjust the SWEEP WIDTH LIMIT until the pips are under the plus-and-minus fifth screen divisions. Use L402 to maintain a centered presentation.

NOTE

Adjusting the SWEEP WIDTH LIMIT control will cause the pips to shift in position. They will return in a few seconds.

(6) Change the following controls as indicated:

OPERATION SELECTOR	CENTER CALibration
CHANNEL SELECTOR	18
LINEARITY DECADE RESISTOR	15 K (nominal value)

(7) Adjust CHANNEL CF ADJUST trimmer for channel 18 (C851) so that the marker pip is in the center of the screen. At this point the core will be approximately 1/4 of the way down from the top of the trimmer. If this cannot be done, note the position of L402 and then center the pip by adjusting L402. If only a small change (less than one turn) in the coil setting is required, use the channel 1 trimmers (C825, C826) in place of L402 and turn them until the marker pip is in the center of the screen. Use C825 to obtain a coarse setting and then use C826 to obtain a fine setting. If a large change (greater than one turn) in the coil setting is required, return the coil to its original setting. Set the channel 18 trimmer in the center of its range and center the pip by

changing the value of the factory-select capacitor C975. The factory-select tuning capacitors are mounted on two terminal boards one on each side of the swept-oscillator section. They are made accessible by removal of the oscillator-section side covers. See Figure V-6.

(8) Change the following controls as indicated.

OPERATION SELECTOR	CENTER CALibration
CHANNEL SELECTOR	1
LINEARITY DECADE RESISTOR	820 K ohms (nominal value)
SELECTIVITY DECADE RESISTOR	4.7 K ohms (nominal value)

(9) Adjust the numbered piston trimmers located on top of the oscillator subchassis for each channel with a small blade screwdriver. Turn each trimmer until the pip is in the center of the screen.

NOTE

Several channels have two trimmers to adjust.

(10) Set OPERATION SELECTOR to LIMITS CALibration. Two pips should appear, three divisions from center of the screen. If the pips are not evenly spaced, adjust the Linearity Decade Resistor. This will change center frequency. Readjust the piston trimmers for centered presentation. If the pips are not three divisions to each side of center, a small adjustment of the Linearity Decade Resistor will correct this without disturbing linearity.

(11) Once channel 1 and 18 have been aligned, close the dust cover of L402. Further adjustments of L402 or the SWEEP WIDTH LIMIT are not required.

(12) Align each channel in turn using the procedure specified in steps 2, 3 & 4 but using the CHANNEL CF ADJUST trimmer in place of L402 and the Linearity Decade Resistor in place of the SWEEP WIDTH LIMIT control. On channels 1 and 2, the limit marker pips should appear at ±3 divisions, on channels 3 and 4 at ±3-1/2 divisions, on channels 5 and 6 at ±4 divisions, on channels 7 and 8 at ±4-1/2 divisions, and on channels 9 and above at ±5 divisions. If a trimmer capacitor has insufficient range, set it to the center of its electrical range and change the corresponding factory-adjust capacitor to provide the desired result. Note that channel 2 has two trimmers. C827 (meshing plate trimmer) is a coarse adjustment, while C828 (piston trimmer) is a fine adjustment. Note also that it may be necessary to adjust the Selectivity Decade Resistor on particular channels in order to obtain usable pips on the screen.

5. Resolution Adjustments

(a) If the resolution is poor on a particular channel, it is necessary to either redetermine the fixed or adjust the variable resistor associated with the particular channel.

In the case of the factory-selected resistors (R801, R802 and R803) each should be removed one at a time and a precision Decade Resistor connected between pin "D" of J408 and chassis ground and then the box should be adjusted to determine the resistance value that provides optimum resolution.

(b) The subminiature variable resistors. (R804 through R823) should each be adjusted for optimum resolution.

6. Balance

If the TMC-1a BALANCE control (R676) is not properly set, a pip will appear on the right side of the screen on each beam sweep that the TMC-1a is conditioned to pass input signals. Adjust the BALANCE control to minimize this pip.

7. Gain

(a) Set the TMI-1b level controls as follows:

SCALE MULTIPLIER	X10
INPUT LEVEL, STEP	60
INPUT LEVEL, CONTINUOUS	1 division less than MAXimum
SCALE SELECTOR	LINear

(b) Set the CHANNEL SELECTOR to 18 and INPUT AMPLITUDE completely clockwise.

(c) Connect the signal generator to the TMC-1a input terminals.

(d) Set the signal-generator frequency to 70,000 cps (the center frequency of channel 18) and output amplitude to 10 millivolts.

(e) Adjust the TMC-1a CAL GAIN control (R688) for a full-scale input-signal pip. Do not be confused by the marker pips.

8. Output Flatness

If the difference in fundamental amplitude of the limit markers for channel E exceeds ±10% select the correct value of C565. Reduce

the capacitance of C565 to increase the amplitude of the high-frequency marker. Increase the capacitance of C565 to reduce the amplitude of the high-frequency marker.

If the variation in marker amplitude from channel to channel is greater than 6 db, then change values of R412, R422, R440, R450, R470, R480, and/or R490 as required. Increase the resistance to increase the marker output level and decrease it to reduce the output level. Select R412 for channels 18 and E. Select R422 for channels 15, B, 16, C, 17, and D. Select R440 for channels 13, 14, and A. Select R450 for channels 11 and 12. Select R460 for channels 9 and 10. Select R470 for channels 7 and 8. Select R480 for channels 4, 5, and 6. Select R490 for channels 1, 2, and 3.

When adjusting marker amplitude note that the amplitude of the fundamental output for the UPPER LIMIT, CENTER FREQuency, and LOWER LIMIT positions should be between 0.5 and 1.5-volts rms.

Readjust CAL GAIN as required.

V-4. TROUBLE SHOOTING

This section is intended as a guide to trouble shooting the TMI-1b, TMP-1b, and TMC-1a. The principal types of troubles that may be encountered are considered. For each trouble the likely causes are indicated. When a tube is listed as a likely cause, this implies an investigation of the tube and its associated circuitry.

For details concerning adjustments, refer to section V-1 and V-3.

a. MODELS TMI-1b and TMP-1b.

Symptom	Procedure
Pilot lamp does not light	Check 3 amp fuses (F902, F903). Replace pilot lamp. Check power connections.
3 amp fuse (F902, F903) blows when replaced.	Check for B+ short. Check T901 and T902 and their loads.
3/8 amp fuse (F901) blows when replaced.	Check for short to ground in dc filament string. Check for cathode-to-filament short in tubes in dc filament string.
No crt illumination	Check adjustment of FOCUS and BRILLIANCE controls. Check high voltage. If H V is incorrect, check V905 and H V Filter
Dot on crt.	Check B+. If B+ is incorrect, check V901, V902, V903, V904, and B+ filter. Check V119 and V120.
Sweep rate not 1 cps.	Adjust 1 CYC SWEEP RATE. Check V119.
Baseline size and/or horizontal position incorrect.	Check control adjustments (see alignment procedure). Check V112, V120.
Vertical position of baseline incorrect.	Adjust VERTical POSition. Check V108, V109.

SWEEP RANGE SELECTOR on LOGarithmic

With FREQuency MARKERS set to ON, only 85-kc marker appears.	Check V115 and assembly Y103. Check screen frequency calibrations with signal generator.
With FREQuency MARKERS set to ON, only 350-cps and 5-kc markers appear.	Check V116 and Y104. Check screen frequency calibrations with signal generator.

(continued)

Symptom	Procedure
With FREQuency MARKERS set to ON, no markers appear.	Check V115, V116, Y103, Y104. Check screen frequency calibration. If incorrect, check V110, V111, V101, V102, V103, V104, V105, V106, V107, V108, V109, V118.
Frequency calibrations incorrect.	Adjust LOGarithmic 350~ and LOGarithmic 5 KC. Adjust 350 CYC PAD. Check V118. Warning: If the oscillator coil (L104) is adjusted, a complete LINear and LOGarithmic frequency scale alignment will be required.
Resolution inproper. (Use internal markers to evaluate.)	Adjust LOG SELECTIVITY SWEEP and LOG SELECTIVITY ADJUST. Check V112, V113, and the crystal filters.
Pip height not within flatness specification for constant amplitude input of 350 cps to 85 kc.	Adjust FLATNESS control.

SWEEP RANGE SELECTOR on LINear

(LOG operation satisfactory with internal markers ON and also with external signal.)

With CENTER FREQuency set to 5 KC, SWEEP WIDTH set to 20 KC, and FREQuency MARKERS to ON no pips appear.	Check V117.
SWEEP WIDTH and/or CENTER FREQuency Dials out of calibration.	Adjust LIN 350~ and SWEEP LIMIT. Check V117.
Resolution improper.	Adjust LIN SELECTIVITY ADJUST.

b. MODEL TMC-1a USED WITH TMI-1b.
(TMI-1b operation satisfactory on LIN and LOG.)

NOTE

The SWEEP RATE INDICATOR provides information as to whether or not the TMC-1a blocking tube oscillator, and Z413 and Z420 are operating. The CHANNEL INDICATORS provide information as to whether or not the divider chain is providing an output

Symptom	Procedure
Sweep rate and/or baseline size and position incorrect. SWEEP RATE INDICATOR continually on or continually off.	Adjust TMC-1a SWEEP RATE. Adjust TMI-1b 2 CYCLE SWEEP RATE and 2 CYC LINE SIZE. (See alignment procedure.) Check V412A, V413, V419, V420.

(continued)

Symptom	Procedure
With all front panel controls correctly set, marker pips do not appear on any channel.	Check cables between TMI-1b and TMC-1a. Check divider chain (Z401-Z409). Check V414, V415, V419B, V421, V423, V424, V425. Check swept-oscillator alignment. (See alignment procedure.) Check resolution voltages.
Markers missing on one or several channels.	Adjust TRIGGER ADJ. (Note original location so as to be able to return to it if this control is not at fault.) Check V415. Check swept-oscillator alignment for the channels in question. (See alignment procedure.) Check divider chain (Z401-Z409). Check resolution voltages.
Either upper and center or lower limit markers do not appear for all channels.	Check either V410 or V411. Check V413. Check swept-oscillator alignment. (See alignment procedure).
Either upper, center, or lower limit marker does not appear on one channel.	Check crystal. Check TRIGGER ADJ. Check swept oscillator alignment for channel in question.
With appropriate signal input, markers appear but signal does not.	Check V422, V420. Check cable carrying input signal from TMI-1b to TMC-1a.
Velocity modulation either appears on both input and marker pips or appears on neither. Note: Only slight velocity modulation appears on high frequency channels.	Check BALANCE. Check V412, CR431, CR432.

c. MODEL TMC-1a USED BY ITSELF AS A THREE-POINT MARKER.

NOTE

Be sure that pins A and B of J408 are interconnected by means of the supplied mating plug.

Symptom	Procedure
Marker triads are not present for any channel.	Check divider chain (Z401-Z409). Check V414, V419, V420, V421.
Marker triads are not present for one or several channels	Adjust TRIGGER ADJ. (note original location so as to be able to return to it if this control is not at fault.) Check divider chain (Z401-Z409).
Either upper limit and center frequency markers or lower limit markers are not present on any channel.	Check either V410 or V411. Check V413.
Upper, lower or center frequency marker is not present for one channel.	Check crystal.

d. MODEL TMC-1am, AUTOmatic OPERATION.

In the AUTOmatic position of the OPERATION SELECTOR, when trouble is experienced in sections other than motor, motor circuitry, sequencing of S404, and/or sequencing of S405, the OPERATION SELECTOR should be set to the position corresponding to the AUTOmatic position on which trouble occurred, i.e., UPPER LIMIT, CENTER FREQuency, and/or LOWER LIMIT, and corrective measures taken. Note that malfunction in these positions may be caused by failure in the wiring from S402 to S404 or failure of S404, rather than failure in the standard circuitry of the TMC-1am. When all existing malfunctioning in these positions of the OPERATION SELECTOR have been corrected, return to the AUTOmatic position and correct any difficulties that remain using the techniques suggested below.

1. Motor.

(a) Does not start: If AUTOmatic neon is lit, check motor M401. If AUTO neon is out, check S402G for open.

(b) Does not stop: Check S402G and S405 for shorts.

2. CHANNEL SELECTOR

(a) Cannot be rotated manually because driving dog is engaged in sprocket.
Check S405 for open circuit. Check position of cam. When set correctly, the raised portion of cam should be 180° away from dog tooth.

(b) External Discriminator Monitor Malfunctioning. Check TMC-1am output, discriminator outputs, J420 and S401K. (If S401K is faulty see paragraph 4.1.

3. Motor Driven Switch S404

(a) Output incorrect or missing. Check S404 and associated wiring.

(b) Incorrect marker sequencing. (Correct sequencing would be for example, Channel 4 UPPER LIMIT, CENTER FREQUENCY, LOWER LIMIT: Channel 5 UPPER LIMIT, CENTER FREQUENCY, LOWER LIMIT, etc.) Check position of driving dog on motor shaft. The dog should be facing the sprocket shaft when S404 is changing from LOWER LIMIT to UPPER LIMIT.

4. Voltage and Resistance Readings

When the OPERATION SELECTOR is on AUTOmatic and S404 is on any one of its three positions, UPPER LIMIT, CENTER FREQUENCY, or LOWER LIMIT the appropriate voltage and resistance charts of the respective settings of the OPERATION SELECTOR, UPPER LIMIT, CENTER FREQuency, LOWER LIMIT, are applicable with the following exceptions:

V411: When the AUTOmatic position corresponds to UPPER LIMIT and CENTER FREQuency, V411 will have the same V and R measurements as does the conventional set when the OPERATION SELECTOR is set to LOWER LIMIT.

V410: When the AUTOmatic position corresponds to LOWER LIMIT, the following pins will have readings different from those found when the OPERATION SELECTOR is set to LOWER LIMIT.

Pin No.	Voltage	Resistance
1	20	100 K
2	0	0
7	20	100 K
8	21	22 K

e. VOLTAGE AND RESISTANCE CHARTS, MODEL TMI-1b TMP-1b, AND TMC-1a.

The voltage and resistance charts, Tables V-1, V-2, V-3 and V-4 were made with the three units interconnected for normal operation. All readings taken between point specified and chassis ground using RCA VTVM Model WV-77A.

The following control positions were used:

TMI-1b:

BALANCE controls - proper balance
SCALE SELECTOR - LINear
SCALE MULTIPLIER - X1
FREQ. MARKERS - OFF
INPUT LEVEL, CONTINUOUS - MAXimum
INPUT LEVEL, STEP - 60
SWEEP RANGE SELECTOR - As listed in column labeled
SWEEP RANGE SELECTOR
CENTER FREQuency Dial - 0
SWEEP WIDTH Dial - 100 cps
All other controls set for normal operation.

TMC-1a:

CHANNEL SELECTOR - 1
FREQuency ADJUST - knob marker up
SWEEP WIDTH - knob marker up
OPERATION SELECTOR - As listed in column labeled
OPERATION SELECTOR
(ALL = Reading is same for all positions.
CAL = Reading same for CENTER CAL-

ibration and LIMITS CALibration
U = UPPER LIMIT
C = CENTER FREQuency
L = LOWER LIMIT)
INPUT AMPLITUDE - Completely clockwise

NOTE

DNM - Do not measure. This measurement is a leakage measurement.

Resistance measurements made with line cords disconnected and POWER switches set to OFF.

All voltages listed are dc unless specified otherwise.

N.C. - No connection.

f. Notes Concerning Servicing of TMC-1a Channel Selector Switch and Associated Components (Including Swept-Oscillator Section).

Servicing of the TMC-1a CHANNEL SELECTOR switch by the user is not recommended.

In the event that malfunctioning of the switch occurs, the user should contact Panoramic Electronics, Inc., by letter (or in emergency by telephone) describing in detail the difficulties experienced, whereupon shipping instructions will be furnished.

In the event that field maintenance must be performed, the following information is provided. (See Figure V-6 & Figure V-7).

1. Description

S401 is a 24-position, 10-pole rotary switch. Sections S401C, S401B, and S401A (the order from front to back) are associated with the crystals. The balance of the wafers from front to back are S401D, S401E, S401F, S401GH, and S401IJ. Each suffix letter represents a pole and corresponds to the schematic designation.

S401 is mounted, together with the crystal banks and the swept-oscillator section, on a T-shaped sub-chassis plate which in turn is mounted on the chassis of the TMC-1a.

2. Removal of a crystal socket.

The crystal sockets are mounted on channel-shaped mounting brackets. By removing the three Phillips head mounting screws that hold a bracket to the frame, the bracket can be lifted up sufficiently to permit access to the socket contacts thereby permitting removal of the socket. If the sub-chassis assembly (See 4 below) is not being removed, it will be necessary to remove the left side bracket in order to remove the crystal-socket mounting brackets for channels 1 to 8 (upper, center, and lower).

3. Removal of switch wafers S401GH and S401IJ

(a) To obtain access to the end wafers (S401GH and S401IJ), it is necessary to remove the two side covers of the swept-oscillator section (each held by six screws). The back cover (on which are mounted V415, V423, C886, L402, and J405) can then be hinged back after removing the three screws that hold it at the top.

(b) The end wafers can then be removed from the switch after removal of the nuts on the back end of switch side rods.

(c) In wiring a wafer care should be used. To avoid corrosion, do not handle contacts with the hands. Use a minimum of solder consistent with a good joint. Trim away protruding wire ends. It is recommended that No. 24 AWG (16X No. 36, 1/3" lay) SRIR stranded hookup wire be used. When replacing the wafer to sure that both the stator and rotor are oriented correctly. Note that the shaft hole of the rotor has a notch on one side to aid in orientation. The common contact of the stator is on the bottom side when the stator is correctly oriented.

(d) To remove any other wafer requires the removal of the entire sub-chassis assembly.

4. Removal of the Sub-chassis Assembly

(a) Remove the bottom plate (12 screws).

(b) Disengage the five coaxial plugs that are found on the under side of the chassis.

(c) Set the FREQuency ADJUST and SWEEP WIDTH controls so that their knob markers point to the top of the panel. Set CHANNEL SELECTOR to 1.

(d) Loosen the two rear Allen set screw on the shaft coupling associated with the FREQuency ADJUST and SWEEP WIDTH controls.

NOTE

Be careful at this point and in the balance of this procedure not to change the setting of the FREQuency ADJUST and SWEEP WIDTH controls. Leaving the knobs on the shafts, slide the two shafts out of the way.

(e) Remove the CHANNEL SELECTOR knob.

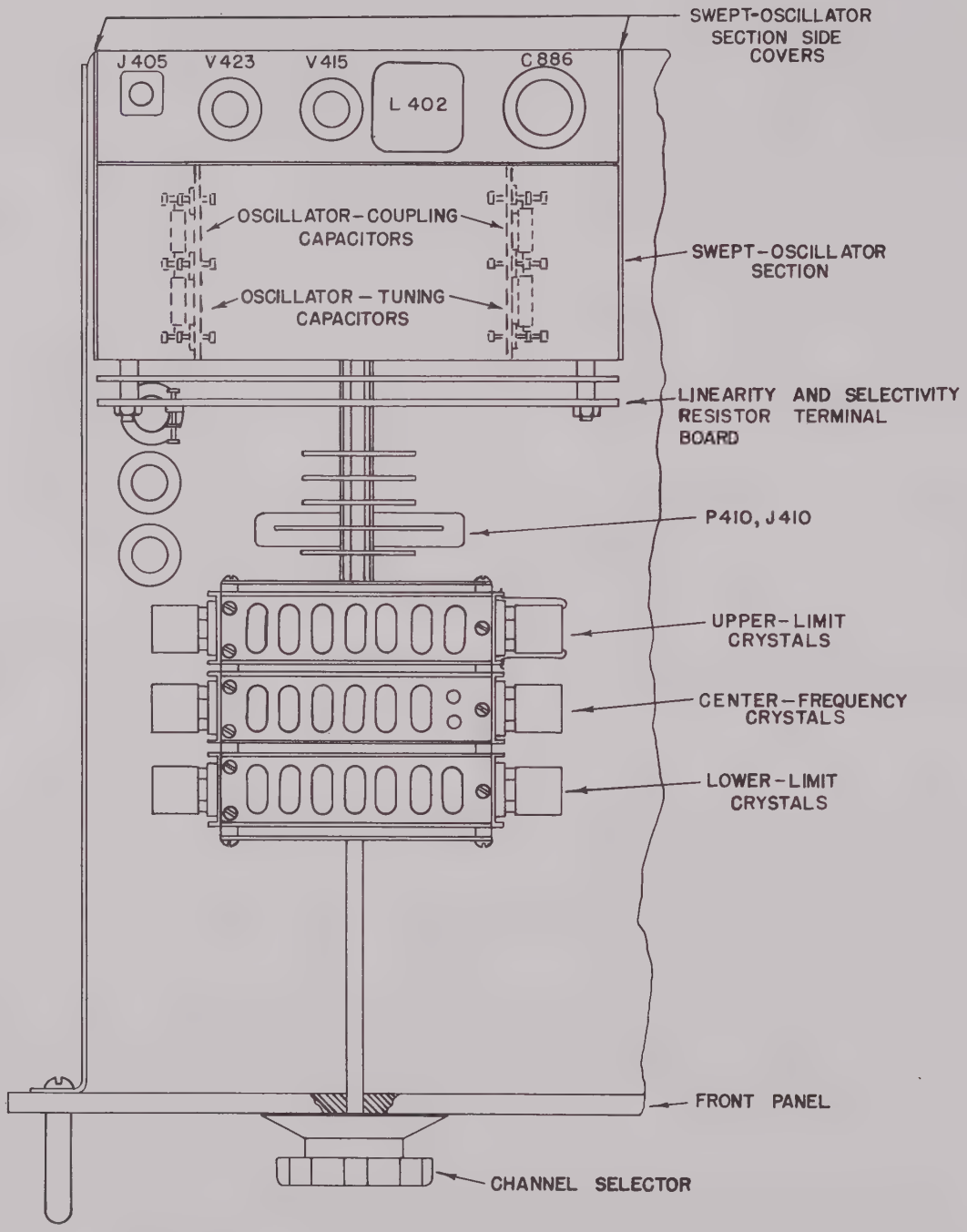


Figure V-6. TMC-1a CHANNEL SELECTOR Switch (with Crystal Banks and Swept-Oscillator Section).

TABLE V-1. VOLTAGE AND RESISTANCE CHART, MODEL TMI-1b.

Tube Sym.	Tube Type	SWEEP RANGE SELECTOR	Pin Numbers																											
			1		2		3		4		5		6		7		8		9		10		11		12		13		14		Anode Cap	
			V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R
V101	12AY7		130	42K	8.3	480K	11.3	24K	33.5	23	46	34	255	6.5K	40	480K	61.5	14K	N.C.	N.C.	--	--	--	--	--	--	--	--	--	--	--	--
V102	12CS6	LOG LIN CAL.	0	0	0.7	120	33.5	23	20.5	10	123	46K	42.5	9.5K	-2.5 -2.5 -2.6	150K	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
V103	5879		0	256K	N.C.	N.C.	5.6	2K	58	46	52	40	N.C.	N.C.	104	50K	237	30K	0	0	--	--	--	--	--	--	--	--	--	--	--	--
V104	5879		0	275K	N.C.	N.C.	5.6	2K	52	40	46	34	N.C.	N.C.	104	50K	237	30K	0	0	--	--	--	--	--	--	--	--	--	--	--	--
V105	6BH6	LOG LIN CAL.	-.25-.25 -4 -5.3	550KΔ 470K 470K	4.6-5 1.0 1.1	10K	2.8AC	100	2.8AC	100	252	8.8K	155-159 164 160	60K	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
V106	6AU6	LOG LIN CAL.	-.25-.25 -4 -5.3	550KΔ 470K 470K	0	0	2.8AC	100	2.8AC	100	252	8.8K	151-153 156 152	60K	4.8-5.2 1.2 1.2	10K	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
V107	6AU6		0	940K	0	0	2.8AC	100	2.8AC	100	250	11K	36	15K	.5	180 Δ	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
V108	6T8	LOG LIN CAL.	N.C.	N.C.	0-.2	250K	.65	150	2.8AC	100	2.8AC	100	N.C.	N.C.	2.2 ϕ	250 ϕ	0	410K	115	200K	--	--	--	--	--	--	--	--	--	--	--	--
V109	5814	LOG LIN CAL.	170	130K	16 16 19	200K	26 26 27.5	9.5K	2.8AC	100	2.8AC	100	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	2.8AC	100	--	--	--	--	--	--	--	--	--	--	--	--
V110 - V111	Osc. Socket	LOG LIN CAL.	255	6.5K	12	6	19-28 29 0	25K	150 150 0	21K 21K ∞	255	6.5K	0	0	0	0	0	10K	16-28 33 0	1.4 meg 47K ∞	D N M	--	7-11 11 0	10K	--	--	--	--	--	--	--	--
V112	6201	LOG LIN CAL.	240 230 237	8K	143 137 141	20K	142 135 140	∞	58	46	70	55	142 135 140	∞	-5.4--8 0 -2.6	350K 110K 110K	0 1.5 .3	560	N.C.	N.C.	--	--	--	--	--	--	--	--	--	--	--	--
V113	6201	LOG LIN CAL.	240 230 237	8K	143 137 141	20K	142 135 140	∞	70	55	82	65	142 135 140	∞	-5.4--8 0 -2.6	350K 110K 110K	0 1.5 .3	560	N.C.	N.C.	--	--	--	--	--	--	--	--	--	--	--	--
V114 ⊗	5ADP7	LOG LIN CAL.	-1630	1.2 meg***	-1600	1.2 meg***	-1630	1.2 meg***	N.C.	N.C.	-1140	850K***	N.C.	N.C.	105-185 105-185 125-165	60K	124-168 124-168 135-160	60K	160**	52K**	170	130K	115	200K	N.C.	N.C.	N.C.	N.C.	-1630	1.2 meg***	1820	20 meg***
V116	5751	LOG LIN CAL.	39* 39* 0*	1.5 meg* 1.5 meg* ∞*	-1* -1* 0*	445K	0	0	2.8AC	100	2.8AC	100	255* 255* 0*	6.5K* 6.5K* ∞*	0	0	N.C.	N.C.	2.8AC	100	--	--	--	--	--	--	--	--	--	--	--	--
V117	12AY7		255	6.5K	28	7K	33	47K	20.5	10	20.5	10	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	12	6	--	--	--	--	--	--	--	--	--	--	--	--
V118	2D21	LOG LIN CAL.	-26 --28 -26--28 -27--29	620K	0	0	2.8AC	100	2.8AC	100	N.C.	N.C.	18-32 18-32 19-29	1.3 meg	0	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
V119	5814	LOG LIN CAL.	32-60 32-60 42-63	15 meg 15 meg 7.5 meg	-10--23 -10--23 -14--22	2.8 meg Δ 2.8 meg Δ 1.5 meg Δ	0	0	2.8AC	100	2.8AC	100	255	6.5K	33-60 33-60 45-63	15 meg 15 meg 7.5 meg	55-87 55-87 63-80	28K	2.8AC	100	--	--	--	--	--	--	--	--	--	--	--	--
V120	5814	LOG LIN CAL.	105-185 105-185 125-165	60K	22-38 22-38 27-34	120K	32-40 32-40 34-38	10K Δ	2.8AC	100	2.8AC	100	124-168 124-168 135-160	60K	31	24K	34-38 34-38 35-37	10K Δ	2.8AC	100	--	--	--	--	--	--	--	--	--	--	--	--
XY103	Marker Osc. Socket	LOG LIN CAL.	0	0	2.8AC	100	255* 255* 0*	6.5K* 6.5K* ∞*	255 255 0	6.5K 6.5K ∞	0	0	10.5	22K	2.8AC	100	10.5	22K	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Legend —
- * FREQuency MARKERS Switch ON.
- ** Depends on setting of R225.
- *** Reverse leads of meter to obtain highest readings.
- ⊗ V115 part of XY103.

N.C. No Connection
Δ Depends on chassis control setting.
ϕ Depends on Factory Select Component.
∞ Infinite. No DC path to chassis ground.

TABLE V-2. VOLTAGE AND RESISTANCE CHARTS, MODEL TMP-1b.

Tube Sym.	Tube Type	Pin Numbers																	
		1		2		3		4		5		6		7		8		9	
		V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R
V901	5R4GY	N.C.	N.C.	390	150K	N.C.	N.C.	370AC	50	N.C.	N.C.	370AC	50	N.C.	N.C.	390V	150K	--	--
V902	6AS7G	200	475K	375	150K	255	6.5K	200	475K	375	150K	255	6.5K	2.8AC	100	2.8AC	100	--	--
V903	5751	125	370K	74	1meg	82●	7K●	82	65	82	65	200	475K	68	535K	70	16.5K●	88	70
V904	5651	87	75K	0	0	N.C.	N.C.	N.C.	N.C.	87	75K	N.C.	N.C.	N.C.	N.C.	--	--	--	--
V905	5651	0	0	-87	110K	N.C.	N.C.	-87	110K	N.C.	N.C.	N.C.	N.C.	-87	110K	--	--	--	--
C902	2x30mfd 450	0	0	N.C.	N.C.	375	150K	2.8AC	N.C.	390	150K	N.C.	N.C.	N.C.	100	N.C.	N.C.	--	--
C901	2x160mfd 150V	0	0	N.C.	N.C.	117	150	N.C.	N.C.	88	50	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	--	--

Legend
● = Depends on setting of R908 and R916

TABLE V-3. VOLTAGE AND RESISTANCE CHARTS, MODEL TMC-1a.

Tube Sym.	Tube Type	OPERATION SELECTOR	Pin Numbers																	
			1		2		3		4		5		6		7		8		9	
			V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R	V	R
Z401	-- --	CAL UCL	0	∞	60	22K 19K	-72	2.9K 2.7K	60	21K 19K	205	8K 5K	120*	80K*	5.5VAC	LOW	0	0	--	--
Z402	-- --	CAL UCL	1●	3.6K●	70	17.5K 16K	-72	2.9K 2.7K	72	19K 17K	205	8K 5K	130	50K	5.5VAC	LOW	0	0	--	--
Z403	-- --	CAL UCL	1●	3.6K●	70	18.5K 16.5K	-72	2.9K 2.7K	72	19K 17K	205	8K 5K	140	65K	5.5VAC	LOW	0	0	--	--
Z404	-- --	CAL UCL	1●	33K●	69	46K 43K	-65	13K	70	45K 42K	145	8K 4.5K	70	18.5K 16.5K	5.5VAC	LOW	0	0	--	--
Z405	-- --	CAL UCL	2●	62K●	69	46K 43K	-72	2.9K 2.7K	70	45K 42K	145	8K 4.5K	69	46K 43K	5.5VAC	LOW	0	0	--	--
Z406	-- --	CAL UCL	2●	75K●	69	46K 43K	-72	2.9K 2.7K	70	45K 42K	145	8K 4.5K	69	46K 43K	5.5VAC	LOW	0	0	--	--
Z407	-- --	CAL UCL	3●	100K●	69	46K 43K	-72	2.9K 2.7K	70	45K 42K	145	8K 4.5K	DNM	∞	5.5VAC	LOW	0	0	--	--

*Depends on setting of chassis controls.
●Depends upon value of factory selected components-nominal value given.

TABLE V-4. VOLTAGE AND RESISTANCE CHARTS, MODEL TMC-1a (continued)

Tube Sym.	Tube Type	OPERATION SELECTOR	Pin Numbers 1 V	1 R	2 V	2 R	3 V	3 R	4 V	4 R	5 V	5 R	6 V	6 R	7 V	7 R	8 V	8 R	9 V	9 R	10 V	10 R	11 V	11 R
Z408	--	CAL UCL	3●	100K●	69	46K 43K	-72	2.9K 2.7K	70	45K 42K	145	8K 4.5K	DNM	∞	5.5VAC	LOW	0	0	--	--	--	--	--	--
Z409	--	CAL UCL	3●	120K●	69	46K 43K	-65	13K	70	45K 42K	145	8K 4.5K	69	46K 43K	5.5VAC	LOW	0	0	--	--	--	--	--	--
V410	12AT7	CENTER CAL. LIMITS CAL. U C L	70 70 90 85 0	100K 100K 100K 100K ∞	-12 -10 -10 -12 -1.2	270K	0	0	DNM	∞	DNM	∞	205	8K 8K 5K 5K 5K	70 70 90 85 0	100K 100K 100K 100K ∞	85 95 95 90 5	22K	DNM	∞	--	--	--	--
V411	12AT7	CENTER CAL. LIMITS CAL. U C L	0 80 0 0 80	127K 100K 127K 127K 100K	-.5 -10 -.5 -.5 -10	270K	0	0	DNM	∞	DNM	∞	205	8K 8K 5K 5K 5K	0 80 0 0 80	127K 100K 127K 127K 100K	5 85 5 5 85	22K	DNM	∞	--	--	--	--
V412	5814	CAL UCL	105 -.5	680K ∞	-14 -.5	1.3meg	0	0	DNM	∞	DNM	∞	205	8K 5K	0-110 7.5	1.1meg	0-120 18	80K	DNM	∞	--	--	--	--
Z413	--	CAL U, C L	25-80 0 87	40K 0 38K	145	8K 4.5K 4.5K	92-125 117 117	82K	-.8-.8 0 0	4.7 meg	25-80 10 85	30K 7.4K 28K	0	0	5.5VAC	LOW	-72	2.9K 2.7K 2.7K	83-88 84 84	50K	5-95 84 0	38K 38K 0	25-80 85 10	30K 28K 7.4K
V414	12AT7	CAL UCL	145	8K 4.5K	1.8	1meg	4	1.2K	DNM	∞	DNM	∞	130	13K 9.5K	2	2.2K	4	1.2K	DNM	∞	- --	--	--	--
V415	12AT7	CAL UCL	85 -.5	25K DNM	-6-8 -0.4	47K	0.6 0	240	DNM	∞	DNM	∞	128 -0.4	31K DNM	-2-2 -3.5-0	4.5meg	4-8 0	200K	DNM	∞	--	--	--	--
V416	5R4GY	CAL UCL	N.C.	N.C.	220	8.2K 5.2K	N.C.	N.C.	330VAC	1.6K	N.C.	N.C.	330VAC	1.6K	N.C.	N.C.	220	8.2K 5.2K	--	--	--	--	--	--
V417	OA2	CAL UCL	150	8.1K 4.6K	N.C.	N.C.	205	100K	N.C.	N.C.	150	8.1K 4.6K	205	100K	0	0	N.C.	N.C.	--	--	--	--	--	--
V418	OA3	CAL UCL	N.C.	N.C.	-72	2.9K 2.7K	-133	1.6K	N.C.	N.C.	0	0	N.C.	N.C.	-133	1.6K	N.C.	N.C.	--	--	--	--	--	--
V419	12AT7	CAL UCL	145	8K 4.5K	-.8-.8 0	4.7meg	3-4 3.2	10K	DNM	∞	DNM	∞	145	8K 4.5K	4.8-5.3 5	1meg	7.9-8.5 8.2	2.7K	DNM	∞	--	--	--	--
Z420	--	CAL UCL	-1.7-.5 145	13K 4.5K	5-105 87	30K	5-105 18	33K 30K	145	8K 4.5K	92-125 117	82K	-72	2.9K 2.7K	5.5VAC	LOW	0	0	--	--	--	--	--	--
V421	12AT7	CAL UCL	145	8K 4.5K	-35-25 -25	250K	-3-23 2.4	4.4K*	DNM	∞	DNM	∞	90-92 90	100K	0	7.1K 62K	-3-23 2.4	4.4K*	DNM	∞	--	--	--	--
V422	12AT7	CAL UCL	90-92 90	100K	0	50K	-2-18 11	4.4K*	DNM	∞	DNM	∞	145	8K 4.5K	-38-25 11	250K	-2-18 11	4.4K*	DNM	∞	--	--	--	--
V423	12AT7	CAL UCL	135 -.5	9.5K	9 -.6	2.2meg	15 0	5.1K	DNM	∞	DNM	∞	96 -.5	45K ∞	-2 -.5	470K	0	0	DNM	∞	--	--	--	--
V424	6AL5	CAL UCL	120*	80K*	60	21K 19K	DNM	∞	DNM	∞	120*	80K*	N.C.	N.C.	60	22K 19K	--	--	--	--	--	--	--	--
V425	12AT7	CENTER CAL. LIMIT CAL. U C L	165 175-177 179 176 180	12K 12K 9K 9K 9K	-55--62 -6--27 -28 -28 -8.6	85K 500K 500K 500K 500K	0	0	DNM	∞	DNM	∞	165 175-177 179 176 180	12K 12K 9K 9K 9K	-7.8 -6--29 -9 -9 -30	340K 500K 500K 500K 500K	0	0	DNM	∞	--	--	--	--

*Depends on setting of chassis controls.
●Depends upon value of factory selected components-nominal value given.

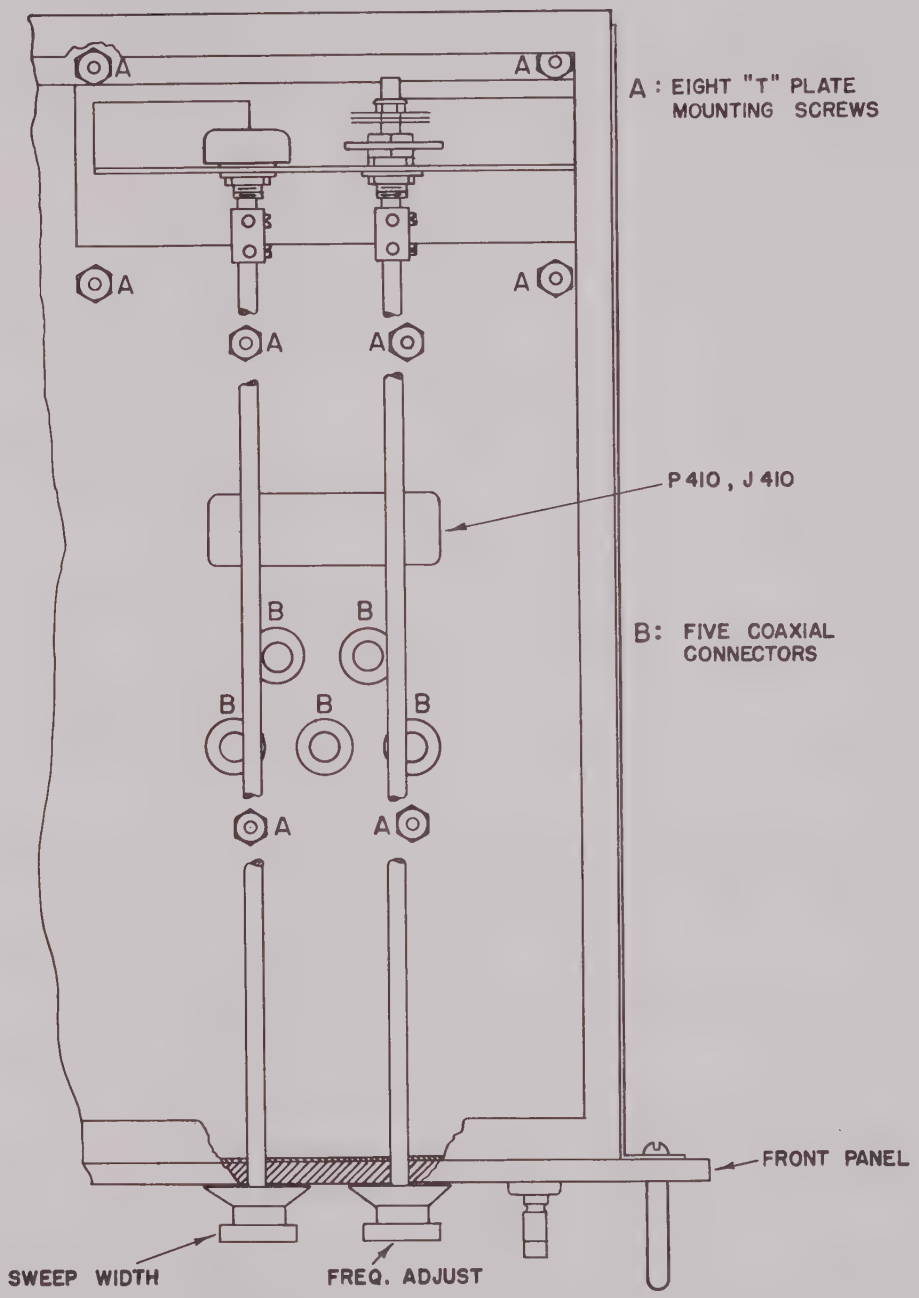


Figure V-7. TMC-1a CHANNEL SELECTOR Switch (with Crystal Banks and Swept-Oscillator Section). Bottom View

(f) Remove the eight 8-32 nuts of the T-Plate mounting screws.

(g) Lift up the assembly sufficiently to disengage the 24-contact ribbon connector (P410, J410).

(h) Lift up the assembly sufficient to clear the bracket to which the FREQuency ADJUST and SWEEP WIDTH controls are mounted being careful not to damage components mounted on this bracket.

(i) The sub-chassis assembly is now free.

5. Removal of a switch wafer*

Once the sub-chassis assembly has been removed from the TMC-1a chassis the following procedure is used to remove a wafer. Note that to remove one of the wafers that is associated with the crystals, it is necessary to move aside the three crystal mounting brackets associated with the wafer in question.

(a) Remove the slotted crystal-assembly front plate (4 screws).

(b) The front of the switch is mounted on a triangular-shaped bracket. Remove the two mounting screw that hold the bracket to the T-Plate.

(c) Remove the two nuts at the rear of the switch side rods.

(d) Clip off leads connected to the wafer to be removed at the point of origin of the lead rather than at the wafer so as to be able to remove the wired wafer as a guide to wiring a new wafer.

(e) Push the switch side rods forward with 1/8 inch diameter rods until the junction of the 1/8 inch rods and the side rods is at the wafer to be removed. Note that the detent, shaft, and triangular mounting bracket will come forward. The purpose of the 1/8 inch diameter rods is to prevent the switch spacers from falling out. Pull the four rods apart slightly and remove the wafer.

(f) When replacing a wafer, a pre-wired wafer should be used. See Section 3(c) above for information concerning wafer wiring and replacement.

* See Section 3 above for technique of removing the two rearmost wafers.

V-5. LIST OF REPLACEABLE PARTS

a. This list is divided into two sections. The first section covers Models TMI-1b and TMP-1b. The second section covers Model TMC-1a.

b. In the case where an item appears more than once, the total quantity is listed only once in the "number in set" column. It is listed the first time the item appears.

c. A list of the Manufacturers Code Letters used is located at the end of this list.

d. In some cases, values, ratings and source (manufacturer) shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement for the part removed from the equipment.

When ordering parts from the factory always include the following information:

1. Instrument Model Number.
2. Serial Number of Instrument
3. Circuit Reference Symbol.
4. Description of Part.
5. Panoramic Part Number.

List of Replaceable Parts for Model TMI-1b and Model TMP-1b

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C101		CAPACITOR: fixed, ceramic, tubular, 15 uuf, ±10%, NPO Pan Part CC1086-13	AR CC21CK150K	1	
C102		CAPACITOR: fixed, ceramic, tubular, 5 uuf, ±.25 uuf, NPO Pan Part CC1211-13	AR CC21CH050C	1	
C103		CAPACITOR: fixed, ceramic, tubular, 2 uuf, ±1% uuf, 500 V, NPO Pan Part CC2072-13	AR CC21CK020C	1	
C104		CAPACITOR: fixed, ceramic, tubular, 1 uuf, ±.25 uuf, NPO Pan Part CC1274-13	AR CC21CK010C	1	
C105		CAPACITOR: fixed, mica, foil, 10,000 uuf, 10% Pan Part CM35B103K	AQ CM35B103K	10	
C106		CAPACITOR: fixed, mica, foil, 10,000 uuf, 10% Pan Part CM35B103K	AQ CM35B103K		
C107		CAPACITOR: fixed, paper, bathtub, 2 x .25 uf, +20% -10%, 600 V Pan Part CP55B4EF254V	BG CP55B4EF254V	1	
C108		CAPACITOR: fixed, mica, silver, 10,000 uuf, 10% Pan Part CM35C103K	AQ CM35C103K	3	
C109		CAPACITOR: fixed, mica, silver, 10,000 uuf, 10% Pan Part CM35C103K	AQ CM35C103K		
C110		CAPACITOR: fixed, mica, silver, 10,000 uuf, 10% Pan Part CM35C103K	AQ CM35C103K		
C113		CAPACITOR: fixed, paper, plastic molded, tubular, .1 uf, 400 V, ±20% Pan Part CT2011	BG 4TM-P1	1	
C115 A,B,C		CAPACITOR: fixed, paper, bathtub, 3 x .1 uf, ±10%, 600 V Pan Part CP55B5EF104K-1	BG CP55B5EF104K	1	

Note: For actual values of factory selected components, see applicable schematic diagram.

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C116		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD1032	23	
C117 A,B		CAPACITOR: fixed, electrolytic, plug-in, 2 x 16 uf, 450 V Pan Part CE52F160R-1	BG CE52F160R	1	
C118		CAPACITOR: fixed, mica, silver, 56 uuf, ±5% Pan Part CM20C560J	AQ CM20C560J	1	
C119		CAPACITOR: fixed, mica, silver, 470 uuf, ±5% Pan Part CM20C471J	AQ CM20C471J	7	
C120		CAPACITOR: fixed, mica, silver, factory selected, 180 uuf, ±5%, nominal value Pan Part CM20C181J	AQ CM20C181J	1	
C121		CAPACITOR: fixed, mica, silver, 1000 uuf, ±5% Pan Part CM25D102J	AQ CM25D102J	4	
C122		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C123		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C124		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C125		CAPACITOR: fixed, silver, mica, factory selected, 820 uuf, ±5%, nominal value Pan Part CM25C821J	AQ CM25C821J	1	
C126		CAPACITOR: fixed, ceramic, disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C127		CAPACITOR: fixed, ceramic, disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C128		CAPACITOR: variable, silvered ceramic, button type, 7 - 45 uuf, N650 Pan Part CV2085-14	AH 822-BN	2	

List of Replaceable Parts for Model TMI-1b and TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C129		CAPACITOR: fixed, ceramic disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C130		CAPACITOR: fixed, ceramic disc, .02 uf, GMV, 500 V Pan Part CC2055-1	BG 29C187A	2	
C131		CAPACITOR: fixed, ceramic disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C132		CAPACITOR: fixed, ceramic disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C133		CAPACITOR: fixed, mica, silver, 270 uuf, ±5% Pan Part CM20C271J	AQ CM20C271J	1	
C134		CAPACITOR: fixed, mica, silver, 470 uuf, ±5% Pan Part CM20C471J	AQ CM20C471J		
C135		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C136		CAPACITOR: variable, silvered ceramic, button type, 7 - 45 uuf, N650 Pan Part CV2085-14	AH 822-BN		
C137		CAPACITOR: synthetic oil, metal case, 1 uf, ±20%, 100 V Pan Part CT-2086-16	BE 5PGX	1	
C138		CAPACITOR: fixed, ceramic disc, .02 uf, 500 V Pan Part CC2055-1	BG 29C187A		
C139		CAPACITOR: Vit. "Q", .047 uf, ±10%, 400 V Pan Part CT2077-1	BG 81P47394S1	1	
C140		CAPACITOR: Vit. "Q", .01 uf, ±10%, 100 V Pan Part CT2076-1	BG 81P10391S1	1	
C141		CAPACITOR: oil filled, 4 uf, 600 V Pan Part CP41B1FF405K-4	AK CP41B1FF405K	2	
C142		CAPACITOR: fixed, mica, foil 10,000 uuf, 10% Pan Part CM35B103K	AQ CM35B103K		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C143		CAPACITOR: fixed, mica, foil, 10,000 uuf, 10% Pan Part CM35B103K	AQ CM35B103K		
C144		CAPACITOR: fixed, ceramic, 82 uuf, ±1%, 500 V, NPO Pan Part CC1009-13	AR CC32CG820F	1	
C145		CAPACITOR: fixed, mica, foil, 10,000 uuf, ±10% Pan Part CM35B103K	AQ CM35B103K		
C146		CAPACITOR: fixed, mica, foil, 10,000 uuf, ±10% Pan Part CM35B103K	AQ CM35B103K		
C147		CAPACITOR: fixed, mica, foil, 10,000 uuf, ±10% Pan Part CM35B103K	AQ CM35B103K		
C148		CAPACITOR: fixed, mica, silver, 150 uuf, ±5% Pan Part CM20C121J	AQ CM20C121J	1	
C149		CAPACITOR: fixed, mica, foil, 10,000 uuf, ±10% Pan Part CM35B103K	AQ CM35B103K		
C150		CAPACITOR: fixed, mica, silver, 470 uuf, ±5% Pan Part CM20C471J	AQ CM20C471J		
C151		CAPACITOR: fixed, mica, silver, 470 uuf, ±5% Pan Part CM20C471J	AQ CM20C471J		
C152		CAPACITOR: fixed, mica, silver, 2200 uuf, ±10% Pan Part CM30E222K	AQ CM30E222K	1	
C153		CAPACITOR: fixed, mica, silver, 47 uuf, ±5% Pan Part CM20C470J	AQ CM20C470J	2	
C154		CAPACITOR: fixed, mica, silver, 47 uuf, ±5% Pan Part CM20C470J	AQ CM20C470J		
C155		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C156		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		

List of Replaceable Parts for Model TMI-1b and TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C157		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C158		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C159		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C160		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C161		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C162		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C163		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CC16XD-1032		
C164		CAPACITOR: fixed, mica, silver factory selected, 470 uuf, ±5% nominal value Pan Part CM20C471J	AQ CM20C471J		
C165		CAPACITOR: fixed, mica, silver, 240 uuf, ±5% Pan Part CM20C241J	AQ CM20C241J	2	
C166		CAPACITOR: fixed, mica, silver, 240 uuf, ±5% Pan Part CM20C241J	AQ CM20C241J		
C167		CAPACITOR: fixed, ceramic, disc, .01 uf, GMV, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C168		CAPACITOR: fixed, mica, silver, 1000 uuf, ±5% Pan Part CM25D102J	AQ CM25D102J		
C169		CAPACITOR: fixed, mica, silver, 1000 uuf, ±5% Pan Part CM25D102J	AQ CM25D102J		
C170		CAPACITOR: fixed, mica, silver, 1000 uuf, ±5% Pan Part CM25D102J	AQ CM25D102J		

List of Replaceable Parts for Model TMI-1b and TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C171		CAPACITOR: fixed, ceramic, disc, .01 uf, 500 V, GMV Pan Part CC2003-2	BU CD16XD-1032		
C172		CAPACITOR: fixed, mica, silver, 120 uuf, ±5% Pan Part CM20C121J	AQ CM20C121J	1	
C173		CAPACITOR: fixed, ceramic, disc, .01 uf, 500 V, GMV Pan Part CC2003-2	BU CD16XD-1032		
C174		CAPACITOR: fixed, mica, silver, 470 uuf, ±5% Pan Part CM20C471J	AQ CM20C471J		
C175		CAPACITOR: oil filled, 4 uf, 600 V Pan Part CP41B1FF405K-4	AK CP41B1FF405K		
C176		CAPACITOR: bathtub, 4 uf, 100 V Pan Part CP54B1EB405K-1	BG CP54B1EB405K	1	
C177		CAPACITOR: fixed, ceramic, disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C178		CAPACITOR: Vit. "Q", .1 uf, ±10%, 100 V Pan Part CT2088-1	BG 81P10491S7	1	
C179		CAPACITOR: .47 uf, ±20%, 200 V Pan Part CT2081-5	CA XMF86-74-2D	1	
C180		CAPACITOR: bathtub 1 uf, 200 V Pan Part CP54B1EC105K-1	BG CP54B1EC105K	1	
C181		CAPACITOR: fixed, paper, tubular, Vit. "Q", .27 uf, 400 V Pan Part CT2079-1	BG 81P27494S1	1	
C182		CAPACITOR: fixed, paper, tubular, .27 uf, Vit. "Q", 400 V Pan Part CT2080-1	BG 81P27494S7	1	
C183		CAPACITOR: fixed, mica, foil, 10,000 uuf, ±10% Pan Part CM35B103K	AQ CM35B103K		
C186		CAPACITOR: fixed, mica, foil, 10,000 uuf, ±10% Pan Part CM35B103K	AQ CM35B103K		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C187		CAPACITOR: fixed, mica, silver, 470 uuf, ±5% Pan Part CM20C471J	AQ CM20C471J		
C901 A,B		CAPACITOR: fixed, electrolytic plug-in, 2 x 160 uf, 150 V Pan Part CE52C161J-1	BG CE52C161J	1	
C902 A,B		CAPACITOR: fixed, electrolytic plug-in, 2 x 20 uf, 500 V Pan Part CE52F200S-1	BG CE52F200S	1	
C903		CAPACITOR: oil-filled, .25 uf, ±10%, 2000 V Pan Part CP70E1EJ254K-1	BG CP70E1EJ254K	3	
C904		CAPACITOR: oil-filled, .25 uf, ±10%, 2000 V Pan Part CP70E1EJ254K	BG CP70E1EJ254K		
C905		CAPACITOR: fixed, ceramic, disc, .01 uf, 500 V, GMV Pan Part CC2003-2	BU CD16XD-1032		
C906		CAPACITOR: fixed, paper, tubular, .1 uf, +40% -15%, 600 V Pan Part CP29A1EF104X-1	BG CP29A1EF104X	1	
C907		CAPACITOR: fixed, paper, .25 uf, ±10%, 2000 V Pan Part CP70E1EJ254K-1	BG CP70E1EJ254K		
CR901		RECTIFIER: selenium, full wave, 120 V, 500 ma Pan Part CR2009	BF D16N6B1H56	1	
CR902		RECTIFIER: selenium, tubular, 2000 V, 5 ma Pan Part CR2005	AX V100HF	2	
CR903		RECTIFIER: selenium, tubular, 2000 V, 5 ma Pan Part CR2005	AX V100HF		
E101		CONNECTOR: second anode Pan Part W4000	AI 3A1	1	
F901		FUSE: slow blow, 3/8 amp, 125 V Pan Part F2005	AY 313.375	2	
F902		FUSE: slow blow, 3 amp,125 V Pan Part F2011	AY 313003	4	

List of Replaceable Parts for Model TMI-1b and TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
F903		FUSE: instantaneous, 3 amp, 125 V Pan Part F2011	AY 313003		
F904		FUSE: slow blow, 3/8 amp, 125 V Pan Part F2005	AY 313.375		
F905		FUSE: instantaneous, 3 amp, 125 V Pan Part F2011	AY 313003		
F906		FUSE: slow blow, 3 amp, 125 V Pan Part F2011	AY 313003		
FL101		FILTER: bandpass, 350 cps to 85 KC, 1000 ohms Pan Part FL2-11011	BD FL-211011	1	
I101		PILOT LAMP: #39 Pan Part B2106	BX 349	4	
I102		PILOT LAMP: #39 Pan Part B2106	BX 349		
I103		PILOT LAMP: #39 Pan Part B2106	BX 349		
I104		PILOT LAMP: #39 Pan Part B2106	BX 349		
I901		LAMP: pilot, miniature bayonet Pan Part B1007	AS 47	1	
J101A		CONNECTOR: post binding Pan Part J2035	BJ 111-103 black	2	
J101B		CONNECTOR: post binding Pan Part J2035	BJ 111-103 black		
J102		CONNECTOR: receptacle, bulkhead, Mil type UG-1094/U Pan Part J2031	AD 31-221	6	
J103		CONNECTOR: receptacle, bulkhead, Mil type UG-1094/U Pan Part J2031	AD 31-221		
J104		CONNECTOR: receptacle, bulkhead, Mil type UG-1094/U Pan Part J2031	AD 31-221		
J105		CONNECTOR: receptacle, bulkhead, Mil type UG-1094/U Pan Part J2031	AD 31-221		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
J106		CONNECTOR: receptacle, bulkhead, Mil Type UG-1094/U Pan Part J2031	AD 31-221		
J107		CONNECTOR: receptacle, bulkhead, Mil type UG-1094/U Pan Part J2031	AD 31-221		
J108		CONNECTOR: receptacle, ten pin, male Pan Part J2030	AD MS3102A-18-1P	1	
J109		CONNECTOR: receptacle, two pin, male Pan Part J2027	AD MS3102A-22-11P	1	
J110		CONNECTOR: receptacle, twelve pin, male Pan Part P2002	AD MS3102A-28-18P	1	
J111		CONNECTOR: receptacle, eleven pin, female Pan Part X2036B	AD 77MIP11	1	
J112		CONNECTOR: receptacle, one pin tip jack, insulated, black Pan Part J2001	AE 407	2	
J901		CONNECTOR: receptacle, one pin tip jack, insulated, black Pan Part J2001	AE 407		
J902		CONNECTOR: receptacle, electrical, 3 wire Pan Part J1002	AV 7486	1	
J903		CONNECTOR: receptacle, five pin, female Pan Part J2028	AD MS3102A-14S-5S	1	
J905		CONNECTOR: receptacle, five pin, male Pan Part J2013	AD MS3102A-14S-5P	1	
J909		CONNECTOR: receptacle, two pin, female Pan Part J2026	AD MS3102A-22-11S	1	
J910		CONNECTOR: receptacle, twelve pin, female Pan Part J2003	AD MS3102A-28-18S	1	
JV110		CONNECTOR: receptacle, eleven pin, female Pan Part J2024	AM SM11-20S	1	

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
L101		COIL: mixer, 100 KC Pan Part ZN-8274	BD ZN-8274	1	
L102		COIL: crystal loading, 100 KC Pan Part ZN-8203	BD ZN-8203	1	
L103		COIL: crystal loading, 100 KC Pan Part ZN-8204	BD ZN-8204	1	
L104		COIL: osillator, 100 - 185 KC Pan Part ZN-8205	BD ZN-8205	1	
L105		CHOKE: ferrite, 2.5 millihenry Pan Part L2019	BA 6302	6	
L106		CHOKE: ferrite, 2.5 millihenry Pan Part L2019	BA 6302		
L107		CHOKE: ferrite, 2.5 millihenry Pan Part L2019	BA 6302		
L108		CHOKE: ferrite, 2.5 millihenry Pan Part L2019	BA 6302		
L109		CHOKE: ferrite, 25 millihenry Pan Part L2021	BA 6308	1	
L110		CHOKE: ferrite, 2.5 millihenry Pan Part L2019	BA 6302		
L111		CHOKE: ferrite, 2.5 millihenry Pan Part L2019	BA 6302		
L901		CHOKE: filter, 8 henry, 110 ma Pan Part L2-10789	BD L2-10789	1	
P109		CONNECTOR: plug, two pin, female Pan Part P2039	AD MS3106A-22-11S	1	
P110		CONNECTOR: plug, twelve pin, female Pan Part P2048	AD MS3106A-28-18S	1	
P111		CONNECTOR: plug, eleven pin, male Pan Part P2031	AD 86-RCP11	1	
P903		CONNECTOR: plug, five pin, male Pan Part P2046	AD MS3106A-14S-5P	1	
P905		CONNECTOR: plug, five pin, female Pan Part P2045	AD MS3106A-14S-5S	1	

List of Replaceable Parts for Model TMI-1b and TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
P909		CONNECTOR: plug, two pin, male Pan Part P2044	AD MS3106A-22-11P	1	
P910		CONNECTOR: plug, twelve pin, male Pan Part P2049	AD MS3106A-28-18P	1	
P911		CLAMP: cable connector Pan Part J2004	AD MS3057-16	2	
P912		CLAMP: cable connector Pan Part J2004	AD MS3057-16		
P913		CLAMP: cable connector Pan Part P2043	AD MS3057-12	2	
P914		CLAMP: cable connector Pan Part P2043	AD MS3057-12		
P915		CLAMP: cable connector Pan Part J1026	AD MS3057-6	2	
P916		CLAMP: cable connector Pan Part J1026	AD MS3057-6		
PV110		CONNECTOR: plug, eleven pin, male, miniature Pan Part P2038	AM SM11-20P	1	
R101		RESISTOR: fixed, metal film, 25 K, ±1%, 1/2 W Pan Part RC20AZ253F	AJ RN15R2502F	1	
R102		RESISTOR: fixed, metal film, 12.5 K, ±1%, 1/2 W Pan Part RC20AZ1252F	AJ RN15R1252F	1	
R103		RESISTOR: fixed, metal film, 6.25 K, ±1%, 1/2 W Pan Part RC20AZ625F	AJ RN15R6251F	1	
R104		RESISTOR: fixed, metal film, 3125 ohms, ±1%, 1/2 W Pan Part RC20AZ31250F	AJ RN15R3121F	1	
R105		RESISTOR: fixed, metal film, 1575 ohms, ±1%, 1/2 W Pan Part RC20AZ15750F	AJ RN15R1571F	1	
R106		RESISTOR: fixed, metal film, 780 ohms, ±1%, 1/2 W Pan Part RC20AZ781F	AJ RN15R7800F	1	
R107		RESISTOR: fixed, metal film, 393 ohms, ±1%, 1/2 W Pan Part RC20AZ3930F	AJ RN15R3930F	1	

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R108		RESISTOR: fixed, metal film, 198 ohms, ±1%, 1/2 W Pan Part RC20AZ1980F	AJ RN15R1980F	1	
R109		RESISTOR: fixed, metal film, 99.5 ohms, ±1%, 1/2 W Pan Part RC20AZ99P5F	AJ RN15R99R5F	1	
R110		RESISTOR: fixed, metal film, 49.5 ohms, ±1%, 1/2 W Pan Part RC20AZ49P5F	AJ RN15R49R5F	1	
R111		RESISTOR: fixed, metal film, 50 ohms, ±1%, 1/2 W Pan Part RC20AZ500F	AJ RN15R50R0F	1	
R112		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745	7	
R113		RESISTOR: fixed, composition, 430 ohms, ±5%, 1/2 W Pan Part RC20BX431J	AB EB4315	1	
R114		RESISTOR: fixed, composition, 510 ohms, ±5%, 1/2 W factory selected Pan Part RC20BX511J	AB EB5115	1	
R115		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035	4	
R116		RESISTOR: variable, composition, linear, 1 K, ±10%, 2 W Pan Part RV018	BD RV2-22018	2	
R117		RESISTOR: fixed, composition, 82 ohms, ±5%, 1/2 W Pan Part RC20BX820J	AB EB8205	1	
R118		RESISTOR: fixed, composition, 22 K, ±5%, 1 W Pan Part RC32BX223J	AB GB2235	2	
R119		RESISTOR: fixed, composition, 1.5 K, ±5%, 1/2 W Pan Part RC20BX152J	AB EB1525	1	
R120		RESISTOR: fixed, composition, 12 K, ±5%, 1/2 W Pan Part RC20BX123J	AB EB1235	2	
R121		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R122		RESISTOR: fixed, composition, 180 K, ±5%, 1/2 W Pan Part RC20BX184J	AB EB1845	6	
R123		RESISTOR: fixed, composition, 22 K, ±5%, 1 W Pan Part RC32BX223J	AB GB2235		
R124		RESISTOR: fixed, composition, 33 K, ±5%, 1 W Pan Part RC32BX333J	AB GB3335	1	
R125		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035		
R126		RESISTOR: fixed, composition, 51 K, ±5%, 1/2 W Pan Part RC20BX513J	AB EB5135	1	
R127		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045	8	
R128		RESISTOR: fixed, composition, 13 K, ±5%, 2 W Pan Part RC42BX133J	AB HB1335	3	
R129		RESISTOR: fixed, composition, 13 K, ±5%, 1 W Pan Part RC32BX133J	AB GB1335	2	
R130		RESISTOR: fixed, composition, 10 K, ±5%, 1 W Pan Part RC32BX103J	AB GB1035	1	
R131		RESISTOR: fixed, composition, 120 ohms, ±5%, 1/2 W Pan Part RC20BX121J	AB EB1215	1	
R132		RESISTOR: fixed, composition, 200 K, ±5%, 1/2 W Pan Part RC20BX204J	AB EB2045	2	
R133		RESISTOR: fixed, composition, 200 K, ±5%, 1/2 W Pan Part RC20BX204J	AB EB2045		
R134 A,B		RESISTOR: variable, composition, concentric, 50 K, ±10%, 2 W, linear (front section) 10 K, ±10%, 2 W, linear (rear section) Pan Part RVC601	BD RVC601	1	

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R135		RESISTOR: fixed, composition, 510 K, ±5%, 1/2 W Pan Part RC20BX514J	AB EB5145	2	
R136		RESISTOR: fixed, composition, 56 K, ±5%, 1/2 W Pan Part RC20BX563J	AB EB5635	4	
R137		RESISTOR: fixed, composition, 75 K, ±5%, 1/2 W Pan Part RC20BX753J	AB EB7535	1	
R138		RESISTOR: fixed, composition, 2 K, ±5%, 1/2 W Pan Part RC20BX202J	AB EB2025	1	
R139		RESISTOR: fixed, composition, 100 K, ±5%, 1 W Pan Part RC32BX104J	AB GB1045	4	
R140		RESISTOR: fixed, composition, 100 K, ±5%, 1 W Pan Part RC32BX104J	AB GB1045		
R141		RESISTOR: fixed, composition, 39 K, ±5%, 1 W Pan Part RC32BX393J	AB GB3935	4	
R142		RESISTOR: variable, composition, linear, 5 K ohms, ±10%, 2 W Pan Part RV012	BD RV012	2	
R143		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		
R144		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035		
R145		RESISTOR: fixed, composition, 180 K, ±5%, 1/2 W Pan Part RC20BX184J	AB EB1845		
R146		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R147		RESISTOR: fixed, composition, 2.2 K, ±5%, 1/2 W Pan Part RC20BX222J	AB EB2225	3	
R148		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R149		RESISTOR: fixed, composition, 180 K, ±5%, 1/2 W Pan Part RC20BX184J	AB EB1845		
R150		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R151		RESISTOR: fixed, composition, 2.2 K, ±5%, 1/2 W Pan Part RC20BX222J	AB EB2225		
R152		RESISTOR: fixed, composition, 51 ohms, ±5%, 1/2 W Pan Part RC20BX510J	AB EB5105	1	
R153		RESISTOR: fixed, composition, 18 K, ±5%, 1/2 W Pan Part RC20BX183J	AB EB1835	4	
R154		RESISTOR: variable, composition, linear, 1 K ohm, ±10%, 2 W Pan Part RV018	BD RV018		
R155		RESISTOR: fixed, composition, 100 K, ±5%, 1 W Pan Part RC32BX104J	AB GB1045		
R156		RESISTOR: fixed, composition, 4.7 K, ±5%, 1/2 W Pan Part RC20BX472J	AB EB4725	1	
R157		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R158		RESISTOR: variable, composition, linear, 500 K ohms, ±10% 2 W Pan Part RV015	BD RV015	2	
R159		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445	2	
R160		RESISTOR: fixed, composition, 150 ohms, ±5%, 1/2 W Pan Part RC20BX151J	AB EB1515	2	
R161		RESISTOR: fixed, composition, 220 ohms, ±5%, 1/2 W, factory selected Pan Part RC20BX221J	AB EB2215		

List of Replaceable Parts for Model TMI-1b and Model TMI-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R162		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R163		RESISTOR: fixed, composition, 68 K, ±5%, 2 W Pan Part RC42BX683J	AB HB6835	1	
R164		RESISTOR: fixed, composition, 220 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2245	4	
R165		RESISTOR: fixed, composition, 220 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2245		
R166		RESISTOR: fixed, composition, 2.2 meg, ±5%, 1/2 W Pan Part RC20BX225J	AB EB2255	1	
R167		RESISTOR: fixed, composition, 220 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2245		
R168		RESISTOR: fixed, composition, 7.5 K, ±5%, 1/2 W Pan Part RC20BX752J	AB EB7525	1	
R169		RESISTOR: fixed, composition, 13 K, ±5%, 1 W Pan Part RC32BX133J	AB GB1335		
R170		RESISTOR: fixed, composition, 75 K, ±5%, 1 W Pan Part RC32BX753J	AB GB7535	1	
R171		RESISTOR: variable, composition, linear, 100 K ohms, ±10%, 2 W Pan Part RV025	BD RV025	3	
R172		RESISTOR: fixed, composition, 120 K, ±5%, 1/2 W Pan Part RC20BX124J	AB EB1245	1	
R173		RESISTOR: fixed, composition, 18 K, ±5%, 1/2 W Pan Part RC20BX183J	AB EB1835		
R174		RESISTOR: variable, composition, linear, 50 K ohms, ±10%, 2 W Pan Part RV014	BD RV014	2	
R175		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		

List of Replaceable Parts for Model TMI-1b and TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R176		RESISTOR: fixed, composition, factory selected, 36 K, ±5%, 1/2 W, nominal value Pan Part RC20BX363J	AB EB3635		
R177 A,B*		RESISTOR: variable, composition dual , 2.5 meg, 2 W, cw taper (front section) 500 K, 2 W, linear, (rear section) Pan Part RVT504A	BD RVT504A		
R178		RESISTOR: fixed, metal film, 15 meg, ±1%, 2 W Pan Part RC40AZ156F	AJ RN30R1505F	1	
R179		RESISTOR: fixed, metal film, 6.6 meg, ±1%, 1 W Pan Part RC30AZ665F	AJ RN25R6604F	1	
R180		RESISTOR: variable, composition, linear, 2.5 megohms, ±20%, 2 W Pan Part RV039	BD RV039	2	
R181		RESISTOR: fixed, composition, 1 meg, ±5%, 2 W Pan Part RC42BX105J	AB HB1055	2	
R182		RESISTOR: variable, composition, linear, 1 megohm, ±20%, 2 W Pan Part RV002	BD RV002	4	
R183		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R184		RESISTOR: fixed, metal film, 2.5 meg, ±1%, 1 W Pan Part RC30AZ255F	AJ RN25R2504F	1	
R185		RESISTOR: variable, composition, linear, 1 megohm, ±20%, 2 W Pan Part RV002	BD RV002		
R186		RESISTOR: variable, composition, linear, 25 K ohms, ±10%, 2 W Pan Part RV026	BD RV026	3	
R187		RESISTOR: fixed, composition, 330 K, ±5%, 1/2 W Pan Part RC20BX334J	AB EB3345	3	

* Mechanically aged part.

List of Replaceable Parts for Model TMI-1b and TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R188		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F	10	
R189		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R190		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R191		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R192		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R193		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R194		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R195		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R196		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R197		RESISTOR: fixed, metal film, 2 K, ±1%, 1 W Pan Part RC30AZ202F	AJ RN25R2001F		
R198		RESISTOR: fixed, composition, 15 K, ±5%, 2 W Pan Part RC42BX153J	AB HB1535	1	
R199		RESISTOR: fixed, metal film, 15 K, ±1%, 1 W Pan Part RC30AZ153F	AJ RN25R1502F	1	
R200		RESISTOR: fixed, metal film, 6.8 K, ±1%, 1 W Pan Part RC30AZ682F	AJ RN25R6801F	1	
R201		RESISTOR: fixed, metal film, 25 K, ±1%, 2 W Pan Part RC40AZ253F	AJ RN30R2502F	1	

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R202		RESISTOR: fixed, composition, 12 ohms, ±5%, 1/2 W Pan Part RC20BX120J	AB EB1205	1	
R203		RESISTOR: fixed, metal film, 250 K, ±1%, 2 W Pan Part RC40AZ254F	AJ RN30R2503F	2	
R204		RESISTOR: fixed, metal film, 12 K, ±1%, 2 W Pan Part RC40AZ123F	AJ RN30R1202F	1	
R205		RESISTOR: fixed, metal film, 500 K, ±1%, 1 W Pan Part RC30AZ504F	AJ RN25R5003F	2	
R206		RESISTOR: fixed, metal film, 25 K, ±1%, 1 W Pan Part RC30AZ253F	AJ RN25R2502F	1	
R207		RESISTOR: fixed, metal film, 1 K, ±1%, 1 W Pan Part RC30AZ102F	AJ RN25R1001F	1	
R208		RESISTOR: fixed, metal film, 20 K, ±1%, 1 W Pan Part RC30AZ203F	AJ RN25R2002F	1	
R209		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015	3	
R210		RESISTOR: fixed, metal film, 500 K, ±1%, 1 W Pan Part RC30AZ504F	AJ RN25R5003F		
R211		RESISTOR: fixed, composition, 39 K, ±5%, 1 W Pan Part RC32BX393J	AB GB3935		
R212		RESISTOR: fixed, metal film, 8.5 K, ±1%, 1 W Pan Part RC30AZ852F	AJ RN25R8501F	1	
R213		RESISTOR: fixed, composition, 2.2 K, ±5%, 1/2 W Pan Part RC20BX222J	AB EB2225		
R214		RESISTOR: fixed, composition, 33 K, ±5%, 1/2 W Pan Part RC20BX333J	AB EB3335	2	
R215		RESISTOR: fixed, composition, 36 K, ±5%, 1/2 W Pan Part RC20BX363J	AB EB3635	2	

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R216		RESISTOR: fixed, composition, 560 ohms, ±5%, 1/2 W Pan Part RC20BX561J	AB EB5615	2	
R217		RESISTOR: fixed, composition, 5.6 K, ±5%, 1/2 W Pan Part RC20BX562J	AB EB5625	2	
R218		RESISTOR: fixed, composition, 5.6 K, ±5%, 1/2 W Pan Part RC20BX562J	AB EB5625		
R219		RESISTOR: variable, composition, linear, 25 K ohms, ±10%, 2 W Pan Part RV026	BD RV026		
R220		RESISTOR: fixed, composition, 560 ohms, ±5%, 1/2 W Pan Part RC20BX561J	AB EB5615		
R221		RESISTOR: fixed, composition, 33 K, ±5%, 1/2 W Pan Part RC20BX333J	AB EB3335		
R222		RESISTOR: fixed, composition, 36 K, ±5%, 1/2 W Pan Part RC20BX363	AB EB3635		
R223		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R224		RESISTOR: fixed, composition, 47 K, ±5%, 1 W Pan Part RC32BX473J	AB GB4735		
R225		RESISTOR: variable, composition, linear, 50 K ohms, ±10%, 2 W Pan Part RV014	BD RV014		
R226		RESISTOR: fixed, composition, 24 K, ±5%, 1 W Pan Part RC32BX473J	AB GB4735		
R227		RESISTOR: variable, composition, 100 K ohms, ±10% Pan Part RVX902	BD RVX902	1	
R228		RESISTOR: fixed, composition, 150 K, ±5%, 1 W Pan Part RC32BX154J	AB GB1545	1	

List of Replaceable Parts for Model TMI-1b and TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R229		RESISTOR: variable, composition, linear, 500 K ohms, ±10%, 2 W Pan Part RVX903	BD RVX903	1	
R230		RESISTOR: fixed, composition, 470 K, ±5%, 1 W Pan Part RC32BX474J	AB GB4745	3	
R231		RESISTOR: fixed, composition, 120 K, ±5%, 1 W Pan Part RC32BX124J	AB GB1245	1	
R232		RESISTOR: variable, wirewound, 6 ohms, 2 W Pan Part RVS700	BD RVS700	1	
R233		RESISTOR: fixed, composition, 180 K, ±5%, 1/2 W Pan Part RC20BX184J	AB EB1845		
R234		RESISTOR: fixed, composition, 180 K, ±5%, 1/2 W Pan Part RC20BX184J	AB EB1845		
R235		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R236		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R237		RESISTOR: fixed, composition, 1.2 meg, ±5%, 1/2 W Pan Part RC20BX125J	AB EB1255	3	
R238		RESISTOR: fixed, composition, 1.2 meg, ±5%, 1/2 W Pan Part RC20BX125J	AB EB1255		
R239		RESISTOR: fixed, composition, 24 K, ±5%, 1/2 W Pan Part RC20BX243J	AB EB2435	2	
R240		RESISTOR: fixed, composition, factory selected, 56 K, ±5%, 1/2 W, nominal value Pan Part RC20BX563J	AB EB5635		
R241		RESISTOR: fixed, composition, 1 meg, ±5%, 1/2 W Pan Part RC20BX105J	AB EB1055	4	
R242		RESISTOR: fixed, composition, 1.8 K, ±5%, 1/2 W Pan Part RC20BX182J	AB EB1825	2	

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R243		RESISTOR: fixed, composition, 1.8 K, ±5%, 1/2 W Pan Part RC20BX182J	AB EB1825		
R244		RESISTOR: fixed, composition, 1.2 meg, ±5%, 1/2 W Pan Part RC20BX125J	AB EB1255		
R245		RESISTOR: fixed, composition, 1 meg, ±5%, 1/2 W Pan Part RC20BX105J	AB EB1055		
R246		RESISTOR: fixed, composition, 1 meg, ±5%, 1/2 W Pan Part RC20BX105J	AB EB1055		
R247		RESISTOR: fixed, composition, factory selected, 3.9 megohms, ±5%, 1/2 W, nominal value Pan Part RC20BX365J	AB EB3655	1	
R248		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		
R249		RESISTOR: fixed, composition, 1.5 meg, ±5%, 1/2 W Pan Part RC20BX155J	AB EB1555	1	
R250		RESISTOR: fixed, composition, 13 K, ±5%, 2 W Pan Part RC42BX133J	AB HB1335		
R251		RESISTOR: fixed, composition, 13 K, ±5%, 2 W Pan Part RC42BX133J	AB HB1335		
R252		RESISTOR: fixed, composition, 18 K, ±5%, 2 W Pan Part RC42BX183J	AB HB1835	1	
R253*		RESISTOR: variable, composition, linear, 10 K ohms, ±10%, 2 W Pan Part RV013A	BD RV013A	1	
R254		RESISTOR: variable, wirewound, 10 turn precision, linear, 50 K, ±5%, 5 W Pan Part RVX915	BD RVX915	1	
R255		RESISTOR: fixed, composition, 10 K, ±5%, 2 W Pan Part RC42BX103J	AB HB1035	2	

* Mechanically aged part.

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R256		RESISTOR: fixed, composition, 10 K, ±5%, 2 W Pan Part RC42BX103J	AB HB1035		
R258		RESISTOR: variable, composition, linear, 2.5 megohms, ±20%, 2 W Pan Part RV039	BD RV039		
R259		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735	1	
R260		RESISTOR: fixed, composition, 1.8 meg, ±5%, 1 W Pan Part RC32BX185J	AB GB1855	2	
R261		RESISTOR: fixed, composition, 1.8 meg, ±5%, 1 W Pan Part RC32BX185J	AB GB1855		
R262		RESISTOR: fixed, composition, 5.1 K, ±5%, 2 W Pan Part RC42BX512J	AB HB5125	1	
R263*		RESISTOR: variable, composition, linear, 5 K ohms, ±10%, 2 W Pan Part RV012	BD RV012	2	
R264		RESISTOR: variable, composition, linear, 25 K ohms, ±10%, 2 W Pan Part RV026	BD RV026		
R265		RESISTOR: fixed, metal film, 22 K, ±1%, 2 W Pan Part RC40AZ223F	AJ RN30R2202F	1	
R266		RESISTOR: fixed, metal film, 250 K, ±1%, 2 W Pan Part RC40AZ254F	AJ RN30R2503F		
R267		RESISTOR: variable, composition, linear, 1 meg ohms, ±20%, 2 W Pan Part RV002	BD RV002		
R268		RESISTOR: fixed, composition, 1 meg, ±5%, 2 W Pan Part RC42BX105J	AB HB1055		
R269		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		

*With 1-3/8" shaft extension.

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R270		RESISTOR: fixed, composition, 330 K, ±5%, 1/2 W Pan Part RC20BX334J	AB EB3345		
R271		RESISTOR: fixed, composition, 180 K, ±5%, 1/2 W Pan Part RC20BX184J	AB EB1845		
R272		RESISTOR: variable, composition, linear, 100 K ohms, ±10%, 2 W Pan Part RV025	BD RV025		
R273		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		
R274		RESISTOR: variable, composition, linear, 500 K ohms, ±10%, 2 W Pan Part RV015	BD RV015		
R275		RESISTOR: fixed, composition, 5.6 meg, ±5%, 1/2 W Pan Part RC20BX565J	AB EB5655	1	
R276		RESISTOR: fixed, composition, 2.7 meg, ±5%, 1/2 W Pan Part RC20BX275J	AB EB2755	1	
R277		RESISTOR: variable, composition, linear, 1 megohms, ±20%, 2 W Pan Part RV002	BD RV002		
R278		RESISTOR: fixed, composition, 13 K, ±5%, 1/2 W Pan Part RC20BX133J	AB EB1335	1	
R279		RESISTOR: fixed, composition, 3.3 K, ±5%, 1/2 W Pan Part RC20BX332J	AB EB3325	1	
R280		RESISTOR: fixed, composition, 15 K, ±5%, 1/2 W Pan Part RC20BX153J	AB EB1535	1	
R281		RESISTOR: fixed, composition, 270 K, ±5%, 1/2 W Pan Part RC20BX274J	AB EB2745	1	
R282		RESISTOR: fixed, composition, 220 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2245		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R283		RESISTOR: fixed, composition, 18 K, ±5%, 1/2 W Pan Part RC20BX183J	AB EB1835		
R284		RESISTOR: fixed, composition, 18 K, ±5%, 1/2 W Pan Part RC20BX183J	AB EB1835		
R285		RESISTOR: variable, composition, linear, 100 K ohms, ±10%, 2 W Pan Part RV025	BD RV025		
R286		RESISTOR: fixed, composition, factory selected, 20 K ohms, 1 W, nominal value Pan Part RC32BX203J	AB GB2035	1	
R287		RESISTOR: variable, composition, linear, 10 K ohms, ±10%, 2 W Pan Part RV005	BD RV005	3	
R288		RESISTOR: fixed, metal film, 200 K, ±1%, 1 W Pan Part RC30AZ204F	AJ RN25R2003F	1	
R289		RESISTOR: fixed, composition, 56 K, ±5%, 1/2 W Pan Part RC20BX563J	AB EB5635		
R290		RESISTOR: fixed, composition, 56 K, ±5%, 1/2 W Pan Part RC20BX563J	AB EB5635		
R291		RESISTOR: fixed, composition, 24 K, ±5%, 1/2 W Pan Part RC20BX243J	AB EB2435		
R292		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015		
R293		RESISTOR: fixed, composition, 330 K, ±5%, 1/2 W Pan Part RC20BX334J	AB EB3345		
R294		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015		
R295		RESISTOR: fixed, composition, factory selected, 39 K ohms, ±5%, 1 W, nominal value Pan Part RC32BX393J	AB GB3935		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R296		RESISTOR: variable, composition, linear, 10 K ohms, ±10%, 2 W Pan Part RV005	BD RV005		
R297		RESISTOR: fixed, composition, factory selected, 39 K ohms, ±5%, 1 W, nominal value Pan Part RC32BX393J	AB GB3935		
R298		RESISTOR: fixed, composition, 47 K, ±5%, 1 W Pan Part RC32BX473J	AB GB4735	3	
R300		RESISTOR: fixed, composition, 39 K, ±5%, 1 W Pan Part RC32BX393J	AB GB3935		
R303		RESISTOR: fixed, composition, 510 K, ±5%, 1/2 W Pan Part RC20BX514J	AB EB5145		
R901		RESISTOR: fixed, wirewound, 100 ohms, 22 W Pan Part RW21G101R	AU RW21G101R	1	
R902		RESISTOR: fixed, composition, 68 K, ±5%, 1/2 W Pan Part RC20BX683J	AB EB6835	1	
R903		RESISTOR: fixed, composition, 220 ohms, ±5%, 1 W Pan Part RC32BX221J	AB GB2215	4	
R904		RESISTOR: fixed, composition, 150 K, ±5%, 2 W Pan Part RC42BX154J	AB HB1545	1	
R905		RESISTOR: fixed, composition, 820 K, ±5%, 1/2 W Pan Part RC20BX824J	AB EB8245	1	
R906		RESISTOR: fixed, composition, 910 K, ±5%, 1/2 W Pan Part RC20BX914J	AB EB9145	1	
R907		RESISTOR: fixed, composition, 470 K, ±5%, 1 W Pan Part RC32BX474J	AB GB4745		
R908		RESISTOR: variable, composition, linear, 5 K ohms, ±10%, 2 W Pan Part RV012	BD RV012		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R909		RESISTOR: fixed, composition, 68 K, ±5%, 1 W Pan Part RC32BX683J	AB GB6835	2	
R910		RESISTOR: fixed, composition, 470 K, ±5%, 1 W Pan Part RC32BX474J	AB GB4745		
R911		RESISTOR: fixed, composition, 12 K, ±5%, 1/2 W Pan Part RC20BX123J	AB EB1235	1	
R912		RESISTOR: fixed, wirewound, 10 K, ±5%, 37 W Pan Part RW22G103R	AU RW22G103	2	
R913		RESISTOR: fixed, wirewound, 10 K, ±5%, 37 W Pan Part RW22G103R	AU RW22G103		
R914		RESISTOR: fixed, composition, 47 K, ±5%, 1 W Pan Part RC32BX473J	AB GB4735		
R915		RESISTOR: fixed, wirewound, 6.3 K, ±5%, 37 W Pan Part RW22G632R	AU RW22G632	1	
R916		RESISTOR: variable, composition, linear, 10 K ohms, ±10%, 2 W Pan Part RV005	BD RV005		
R917		RESISTOR: fixed, composition, 1 meg, ±5%, 1/2 W Pan Part RC20BX105J	AB EB1055		
R918		RESISTOR: fixed, composition, 68 K, ±5%, 1 W Pan Part RC32BX683J	AB GB6835		
R919		RESISTOR: fixed, wirewound, 400 ohms, 22 W Pan Part RW21G401R	AU RW21G401	1	
R920		RESISTOR: fixed, composition, 100 K, ±5%, 1 W Pan Part RC32BX104J	AB GB1045		
R921		RESISTOR: fixed, composition, 10 meg, ±5%, 2 W Pan Part RC42BX106J	AB HB1065	4	
R922		RESISTOR: fixed, composition, 10 meg, ±5%, 2 W Pan Part RC42BX106J	AB HB1065		

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R923		RESISTOR: fixed, composition, 10 meg, ±5%, 2 W Pan Part RC42BX106J	AB HB1065		
R924		RESISTOR: fixed, composition, 10 meg, ±5%, 2 W Pan Part RC42BX106J	AB HB1065		
R925		RESISTOR: fixed, composition, 220 ohms, ±5%, 1 W Pan Part RC32BX221J	AB GB2215		
R926		RESISTOR: fixed, composition, 220 ohms, ±5%, 1 W Pan Part RC32BX221J	AB GB2215		
R927		RESISTOR: fixed, composition, 220 ohms, ±5%, 1 W Pan Part RC32BX221J	AB GB2215		
S101		SWITCH: rotary, 2P11T, ceramic, 2 Wafer, shorting contacts Pan Part S1035	AH 2512	1	
S102		SWITCH: rotary, 1P11T, ceramic, 1 Wafer, shorting contacts Pan Part S1031	AH 2502	2	
S103		SWITCH: toggle, SPDT Pan Part S2053	AL ST42D	1	
S104 A,B C,D		SWITCH: rotary, 12P3T, 4 Wafer Pan Part S2051	BC 58879-H4C	1	
S105		SWITCH: rotary, 1P3T, phenolic, Wafer, with 3 tie points Pan Part S2019	BC 59149-F1	1	
S106		SWITCH: rotary, 1P11T, ceramic 1 Wafer, shorting contacts Pan Part S1031	AH 2502		
S108		SWITCH: toggle, SPST momentary contact Pan Part S2048	AL ST42C	1	
S901		SWITCH: toggle, SPST Pan Part S2052	AL ST42A	1	
T101		TRANSFORMER: IF, 100 KC Pan Part ZN-8207	BD ZN-8207	2	

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
T102		TRANSFORMER: IF, 100 KC Pan Part ZN-8207	BD ZN-8207		
T103		TRANSFORMER: IF, 100 K Pan Part ZN-8206	BD ZN-8206	1	
T104		TRANSFORMER: pulse, B.T.O. Pan Part T2-10790A	BD T2-10790A	1	
T901		TRANSFORMER: Power, low voltage Pan Part T3-9877B	BD T3-9877B	1	
T902		TRANSFORMER: Power, high voltage Pan Part T3-9875	BD T3-9875	1	
T903		TRANSFORMER: Regulator, voltage, 250 VA Pan Part T3017-1	BD T3017-1	1	
V101		ELECTRON TUBE: 12AY7 Pan Part 12AY7	BK 12AY7	2	
V102		ELECTRON TUBE: 12CS6 Pan Part 12CS6	BK 12CS6	1	
V103		ELECTRON TUBE: 5879 Pan Part 5879	BK 5879	2	
V104		ELECTRON TUBE: 5879 Pan Part 5879	BK 5879		
V105		ELECTRON TUBE: 6BH6 Pan Part 6BH6	BK 6BH6	1	
V106		ELECTRON TUBE: 6AU6 Pan Part 6AU6	BK 6AU6	2	
V107		ELECTRON TUBE: 6AU6 Pan Part 6AU6	BK 6AU6		
V108		ELECTRON TUBE: 6T8 Pan Part 6T8	BK 6T8	1	
V109		ELECTRON TUBE: 5814A Pan Part 5814A	BK 5814A	3	
V110		ELECTRON TUBE: 6021A Pan Part 6021A	BK 6021A	1	
V111		ELECTRON TUBE: 12AT7 Pan Part 12AT7	BK 12AT7	1	
V112		ELECTRON TUBE: 6201 Pan Part 6201	BK 6201	2	

List of Replaceable Parts for Model TMI-1b and Model TMP-1b (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
V113		ELECTRON TUBE: 6201 Pan Part 6201	BK 6201		
V114		ELECTRON TUBE: 5ADP7 Pan Part 5ADP7	BK 5ADP7	1	
V115		ELECTRON TUBE: 5751 Pan Part 5751	BK 5751	3	
V116		ELECTRON TUBE: 5751 Pan Part 5751	BK 5751		
XF901		FUSE HOLDER: extractor type Pan Part F2010	AY 342003	3	
XF902		FUSE HOLDER: extractor type Pan Part F2010	AY 342003		
XF903		FUSE HOLDER: extractor type Pan Part F2010	AY 342003		
XI901		LAMP HOLDER: pilot lamp Pan Part B2038	AN 93410-112	1	
Y101*		CRYSTAL: 100 KC Pan Part Y3001-2*	BD Y3001-2	2	
Y102*		CRYSTAL: 100 KC Pan Part Y3001-2*	BD Y3001-2		
Y104		CRYSTAL: quartz, 285.000 KC Pan Part Y3008	BD Y3008	1	
		WRENCH: #8 Allen Pan Part E1009	AC 564	1	
		WRENCH: #4 Allen Pan Part E1009C	AC 050	1	
		TOOL: Alignment Pan Part E1010	BD E1010B	1	

*Supplied as matched pair Panoramic Part No. 2Y3001-2M

List of Replaceable Parts for Model TMC-1a

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C401		CAPACITOR: fixed, silvered mica, 160 uuf, ±5% Pan Part CM20C161J	AQ CM20C1615	2	
C402		CAPACITOR: fixed, silvered mica, 160 uuf, ±5% Pan Part CM20C161J	AQ CM20C1615		
C403		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015	14	
C411		CAPACITOR: fixed, silvered mica, 47 uuf, ±5% Pan Part CM20C470J	AQ CM20C4705	5	
C412		CAPACITOR: fixed, silvered mica, 47 uuf, ±5% Pan Part CM20C470J	AQ CM20C4705		
C413		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C421		CAPACITOR: fixed, silvered mica, 47 uuf, ±5% Pan Part CM20C470J	AQ CM20C4705		
C422		CAPACITOR: fixed, silvered mica, 47 uuf, ±5% Pan Part CM20C470J	AQ CM20C4705		
C431		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405	12	
C432		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C433		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C434		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C435		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032	10	
C441		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C442		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C443		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C444		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C451		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C452		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C453		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C454		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C461		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C462		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C463		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C464		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C471		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C472		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C473		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C474		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C481		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C482		CAPACITOR: fixed, silvered mica, 24 uuf, ±5% Pan Part CM20C240J	AQ CM20C2405		
C483		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C484		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AQ CM20C1015		
C485		CAPACITOR: fixed, ceramic disc, .02 uf, 500 V Pan Part CC2055-1	BG 29C187A	5	
C486		CAPACITOR: fixed, silvered mica, 51 uuf, ±5% Pan Part CM20C510J	AQ CM20C5105	4	
C487		CAPACITOR: fixed, silvered mica, 51 uuf, ±5% Pan Part CM20C510J	AQ CM20C5105		
C513 A,B		CAPACITOR: fixed, paper channel, 2 x .25 uf, +20%, -10%, 600 V Pan Part CP69B4EF254V-1	BG CP69B4EF254V	1	
C519		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C519 A,B,C		CAPACITOR: fixed, electrolytic plug-in, 3 x 20 uf, 450 V Pan Part CE53F200R-1	BG CE53F200R	1	
C520a		CAPACITOR: fixed, silvered mica, 10 uuf, ±5% Pan Part CM20C100J	AQ CM20C1005	3	
C520b		CAPACITOR: fixed, electrolytic plug-in, 25 uf, 450 V Pan Part CE51F250R-1	BG CE51F250R	2	
C521		CAPACITOR: fixed, electrolytic plug-in, 80 uf, 450 V Pan Part CE51F800R-1	BG CE51F800R	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C523		CAPACITOR: fixed, silvered mica, 51 uuf, ±5% Pan Part CM20C510J	AQ CM20C5105		
C525		CAPACITOR: fixed, silvered mica, 82 uuf, ±5% Pan Part CM20C820J	AQ CM20C8205	1	
C526		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C527		CAPACITOR: fixed, silvered mica, 180 uuf, ±5% Pan Part CM20C181J	AQ CM20C1815	2	
C529		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C531		CAPACITOR: fixed, silvered mica, 180 uuf, ±5% Pan Part CM20C181J	AQ CM20C1815		
C533		CAPACITOR: fixed, paper, tubular, .47 uf, ±10%, 200 V Pan Part CT2081-5	CA XMF86-74-20	1	
C534		CAPACITOR: fixed, silvered mica, 56 uuf, ±5% Pan Part CM20C560J	AQ CM20C5605	2	
C535		CAPACITOR: fixed, paper, tubular, .047 uf, ±10%, 400 V Pan Part CT2077-1	BG 81P47394S1	1	
C536		CAPACITOR: fixed, silvered mica, 270 uuf, ±5% Pan Part CM15C271J	AQ CM15C2715	3	
C537		CAPACITOR: fixed, silvered mica, 470 uuf, ±5% Pan Part CM15C471J	AQ CM15C4715	7	
C538		CAPACITOR: fixed, silvered mica, 470 uuf, ±5% Pan Part CM15C471J	AQ CM15C4715		
C539		CAPACITOR: fixed, silvered mica, 430 uuf, ±5% Pan Part CM15C431J	AQ CM15C4315	5	
C540		CAPACITOR: fixed, silvered mica, 22 uuf, ±5% Pan Part CM20C220J	AQ CM20C2205	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C541		CAPACITOR: fixed, silvered mica, 36 uuf, ±5% Pan Part CM20C360J	AQ CM20C3605	1	
C542		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C543		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C561		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C562		CAPACITOR: fixed, silvered mica, 560 uuf, ±5% Pan Part CM20C561J	AQ CM20C5615	2	
C563		CAPACITOR: fixed, silvered mica, 560 uuf, ±5% Pan Part CM20C561J	AQ CM20C5615		
C564		CAPACITOR: fixed, ceramic tubular, 2 uuf, ±.25 uuf, NPO Pan Part CC2072-13	AR CC21CK020C	1	
C565		CAPACITOR: fixed, silvered mica, factory selected, 1000 uuf, ±5%, nominal value Pan Part CM20-102J	AQ CM20-1025	1	
C566		CAPACITOR: fixed, silvered mica, 18 uuf, ±5% Pan Part CM15C180J	AQ CM15C1805	1	
C568		CAPACITOR: fixed, paper, bathtub, 2 uf, ±10%, 200 V Pan Part CP54B1EC205K-1	BG CP54B1EC205K	1	
C569		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C570		CAPACITOR: fixed, paper, plastic molded, tubular, .1 uf, ±20%, 400 V Pan Part CT2011-1	BG 67P10404	1	
C571		CAPACITOR: fixed, ceramic disc, .02 uf, 500 V Pan Part CC2055-1	BG 29C187A		
C572		CAPACITOR: fixed, ceramic disc, .02 uf, 500 V Pan Part CC2055-1	BG 29C187A		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C579		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C580		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C581		CAPACITOR: fixed, ceramic disc, .02 uf, 500 V Pan Part CC2055-1	BG 29C187A		
C801		CAPACITOR: fixed, silvered mica, 33 uuf, ±5% Pan Part CM15C330J	AQ CM15C3305	1	
C802		CAPACITOR: fixed, silvered mica, 43 uuf, ±5% Pan Part CM15C430J	AQ CM15C4305	1	
C803		CAPACITOR: fixed, silvered mica, 56 uuf, ±5% Pan Part CM15C560J	AQ CM15C5605	1	
C804		CAPACITOR: fixed, silvered mica, 68 uuf, ±5% Pan Part CM15C680J	AQ CM15C6805	1	
C805		CAPACITOR: fixed, silvered mica, 91 uuf, ±5% Pan Part CM15E910J	AQ CM15C9105	1	
C806		CAPACITOR: fixed, silvered mica, 120 uuf, ±5% Pan Part CM15C121J	AQ CM15C1215	2	
C807		CAPACITOR: fixed, silvered mica, 150 uuf, ±5% Pan Part CM15C151J	AQ CM15C1515	3	
C808		CAPACITOR: fixed, silvered mica, 160 uuf, ±5% Pan Part CM15C161J	AQ CM15C1615	1	
C809		CAPACITOR: fixed, silvered mica, 180 uuf, ±5% Pan Part CM15C181J	AQ CM15C1815	4	
C810		CAPACITOR: fixed, silvered mica, 180 uuf, ±5% Pan Part CM15C181J	AQ CM15C1815		
C811		CAPACITOR: fixed, silvered mica, 180 uuf, ±5% Pan Part CM15C181J	AQ CM15C1815		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C812		CAPACITOR: fixed, silvered mica, 200 uuf, ±5% Pan Part CM15C201J	AQ CM15C2015	6	
C813		CAPACITOR: fixed, silvered mica, 200 uuf, ±5% Pan Part CM15C201J	AQ CM15C2015		
C814		CAPACITOR: fixed, silvered mica, 200 uuf, ±5% Pan Part CM15C201J	AQ CM15C2015		
C815		CAPACITOR: fixed, silvered mica, 300 uuf, ±5% Pan Part CM15C301J	AQ CM15C3015	4	
C816		CAPACITOR: fixed, silvered mica, 220 uuf, ±5% Pan Part CM15C221J	AQ CM15C2215	2	
C817		CAPACITOR: fixed, silvered mica, 300 uuf, ±5% Pan Part CM15C301J	AQ CM15C3015		
C818		CAPACITOR: fixed, silvered mica, 220 uuf, ±5% Pan Part CM15C221J	AQ CM15C2215		
C819		CAPACITOR: fixed, silvered mica, 300 uuf, ±5% Pan Part CM15C301J	AQ CM15C3015		
C820		CAPACITOR: fixed, silvered mica, 200 uuf, ±5% Pan Part CM15C201J	AQ CM15C2015		
C821		CAPACITOR: fixed, silvered mica, 300 uuf, ±5% Pan Part CM15C301J	AQ CM15C3015		
C822		CAPACITOR: fixed, silvered mica, 200 uuf, ±5% Pan Part CM15C201J	AQ CM15C2015		
C823		CAPACITOR: fixed, silvered mica, 270 uuf, ±5% Pan Part CM15C271J	AQ CM15C2715		
C825		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)	16	
C826		CAPACITOR: variable, glass, piston, 1 - 18 uuf Pan Part CV2099	BD CV2099	2	

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C827		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C828		CAPACITOR: variable, glass piston, 1 - 18 uuf Pan Part CV2099	BD CV2099		
C829		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C830		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C831		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C832		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C833		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C834		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C835		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C836		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C837		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C838		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C839		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C840		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C841		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C842		CAPACITOR: variable, air 4.5 - 100 uuf Pan Part CV2063	BM 34451-15 (Type MAPC-100)		
C843		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV-2089/17	BD CV2089/17	10	
C844		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV-2089	BD CV2089		
C845		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV-2089/18	BD CV2089/18		
C846		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV-2089	BD CV2089		
C847		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV2089/19	BD CV2089/19		
C848		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV-2089	BD CV2089		
C849		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV-2089/20	BD CV2089/20		
C850		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV-2089/21	BD CV2089/21		
C851		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV-2089/22	BD CV2089/22		
C852		CAPACITOR: variable, ceramic piston, 1 - 50 uuf Pan Part CV2089/23	BD CV2089/23		
C853		CAPACITOR: fixed, silvered mica, factory selected, 470 uuf, ±5%, nominal value Pan Part CM15C271J	AQ CM15C2715		
C854		CAPACITOR: fixed, silvered mica, factory selected, 470 uuf, ±5%, nominal value Pan Part CM15C271J	AQ CM15C2715		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C855		CAPACITOR: fixed, silvered mica, factory selected, 470 uuf, ±5%, nominal value Pan Part CM15C271J	AQ CM15C2715		
C856		CAPACITOR: fixed, silvered mica, factory selected, 470 uuf, ±5%, nominal value Pan Part CM15C271J	AQ CM15C2715		
C857		CAPACITOR: fixed, silvered mica, factory selected, 470 uuf, ±5%, nominal value Pan Part CM15C271J	AQ CM15C2715		
C858		CAPACITOR: fixed, silvered mica, factory selected 430 uuf, ±5%, nominal value Pan Part CM15C431J	AQ CM15C4315		
C859		CAPACITOR: fixed, silvered mica, factory selected, 430 uuf, ±5%, nominal value Pan Part CM15C431J	AQ CM15C4315		
C860		CAPACITOR: fixed, silvered mica, factory selected, 430 uuf, ±5%, nominal value Pan Part CM15C431J	AQ CM15C4315		
C861		CAPACITOR: fixed, silvered mica, factory selected, 430 uuf, ±5%, nominal value Pan Part CM15C431J	AQ CM15C4315		
C862		CAPACITOR: fixed, silvered mica, factory selected, 390 uuf, ±5%, nominal value Pan Part CM15E391J	AQ CM15E3915	2	
C863		CAPACITOR: fixed, silvered mica, factory selected, 390 uuf, ±5%, nominal value Pan Part CM15E391J	AQ CM15E3915		
C864		CAPACITOR: fixed, silvered mica, factory selected ±5%, 330 uuf, nominal value Pan Part CM15E331J	AQ CM15E3315	1	
C865		CAPACITOR: fixed, silvered mica, factory selected, 270 uuf, ±5%, nominal value Pan Part CM15C271J	AQ CM15C2715		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C866		CAPACITOR: fixed, silvered mica, factory selected, 240 uuf, ±5%, nominal value Pan Part CM15C241J	AQ CM15C2415	1	
C867		CAPACITOR: fixed, silvered mica, factory selected, 200 uuf, ±5%, nominal value Pan Part CM15C201J	AQ CM15C2015		
C868		CAPACITOR: fixed, silvered mica, factory selected, 180 uuf, ±5%, nominal value Pan Part CM15C181J	AQ CM15C1815		
C869		CAPACITOR: fixed, silvered mica, factory selected, 150 uuf, ±5%, nominal value Pan Part CM15C151J	AQ CM15C1515		
C870		CAPACITOR: fixed, silvered mica, factory selected, 120 uuf, ±5%, nominal value Pan Part CM15C121J	AQ CM15C1215		
C871		CAPACITOR: fixed, silvered mica, factory selected, 110 uuf, ±5%, nominal value Pan Part CM15C111J	AQ CM15C1115	1	
C872		CAPACITOR: fixed, silvered mica, factory selected, 100 uuf, ±5%, nominal value Pan Part CM15E101J	AQ CM15E1015	1	
C873		CAPACITOR: fixed, silvered mica, factory selected, 75 uuf, ±5%, nominal value Pan Part CM15E750J	AQ CM15E7505	1	
C874		CAPACITOR: fixed, silvered mica, factory selected, 47 uuf, ±5%, nominal value Pan Part CM15E470J	AQ CM15E4705	1	
C875		CAPACITOR: fixed, silvered mica, factory selected, 24 uuf, ±5%, nominal value Pan Part CM15C240J	AQ CM15C2405	1	
C876		CAPACITOR: fixed, paper, tubular, 1 uf, ±10%, 200 V Pan Part CT2082-1	BG 91P10592S2	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock Ref.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C877		CAPACITOR: fixed, silvered mica, 150 uuf, ±5% Pan Part CM15C151J	AQ CM15C1515		
C878		CAPACITOR: fixed, paper tubular, .1 uf, ±10%, 100 V Pan Part CT2088-1	BG 81P10491S7	1	
C879		CAPACITOR: fixed, ceramic, disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C880		CAPACITOR: fixed, silvered mica, 51 uuf, ±5% Pan Part CM20C510J	AQ CM20C5105		
C881		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BU CD16XD-1032		
C882		CAPACITOR: fixed, silvered mica, 10 uuf, ±5% Pan Part CM20C100J	AQ CM20C1005		
C883		CAPACITOR: fixed, silvered mica, 10 uuf, ±5% Pan Part CM20C100J	AQ CM20C1005		
C884		CAPACITOR: fixed, silvered mica, 47 uuf, ±5% Pan Part CM20C470J	AQ CM20C4705		
C885		CAPACITOR: fixed, silvered mica, 220 uuf, ±5% Pan Part CM20C221J	AQ CM20C2215	1	
C886		CAPACITOR: fixed, electro-lytic, plug-in, 25 uf, 450 V Pan Part CE51F250R-1	BG CE51F250R		
C887		CAPACITOR: fixed, silvered mica, 56 uuf, ±5% Pan Part CM20C560J	AQ CM20C5605		
C888		CAPACITOR: variable, air 1.2 - 10 uuf Pan Part CV1247	BL PL6000 (Type ZR-10-AS)	1	
C889		CAPACITOR: fixed, ceramic, disc, .02 uf, 500 V Pan Part CC2055-1	BG 29C187A		
CR405		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626	8	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
CR406		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR409		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR410		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR413		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR414		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR417		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR418		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR419		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR421		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
CR422		DIODE: semiconductor, germanium, type 1N626 Pan Part CR1N626	BO 1N626		
F401		FUSE: slow blow, 2 amp, 250 V Pan Part F2016	AG MDL-2	4	
F402		FUSE: slow blow, 2 amp, 250 V Pan Part F2016	AG MDL-2		
F403		FUSE: slow blow, 2 amp, 250 V Pan Part F2016	AG MDL-2		
F404		FUSE: slow blow, 2 amp, 250 V Pan Part F2016	AG MDL-2		
I401		LAMP HOLDER with integral lamp, neon Pan Part B2022	BQ 1A-1369	3	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
I402		LAMP HOLDER with integral lamp, neon Pan Part B2022	BQ 1A-1369		
I403		LAMP: pilot, miniature bayonet Pan Part B1007	AS 47	1	
I404		LAMP HOLDER with integral lamp, neon Pan Part B2022	BQ 1A-1369		
J401		CONNECTOR: receptacle, two pin, male, with ground pin Pan Part J1002	AV 7486	1	
J402 A,B		CONNECTOR: receptacle, one pin, female, black Pan Part J2035	BJ 111-103 black	4	
J403		CONNECTOR: receptacle, bulkhead, male, MIL type UG-1094/U Pan Part J2031	AD 31-221	10	
J404		CONNECTOR: receptacle, bulkhead, male, MIL type UG-1094/U Pan Part J2031	AD 31-221		
J405		CONNECTOR: receptacle, bulkhead, male, MIL type UG-1094/U Pan Part J2031	AD 31-221		
J406		CONNECTOR: receptacle, bulkhead, male, MIL type UG-1094/U Pan Part J2031	AD 31-221		
J407 A,B		CONNECTOR: receptacle, one pin, female, black Pan Part J2035	BJ 111-103 black		
J408		CONNECTOR: receptacle, ten pin, female Pan Part J2023	AD AN3102A-18-1S	1	
J410		CONNECTOR: receptacle, 24 pin, female Pan Part J2029	AD 26-420024S	1	
J413		CONNECTOR: receptacle, bulkhead, male, MIL type UG-1094/U Pan Part J2031	AD 31-221		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
J415		CONNECTOR: receptacle, bulkhead, male MIL-1094/U Pan Part J2031	AD 31-221		
J416		CONNECTOR: receptacle, bulkhead, male, MIL type UG-1094/U Pan Part J2031	AD 31-221		
J417		CONNECTOR: receptacle, bulkhead, male MIL type UG-1094/U Pan Part J2031	AD 31-221		
J418		CONNECTOR: receptacle, bulkhead, male, MIL type UG-1094/U Pan Part J2031	AD 31-221		
J419		CONNECTOR: receptacle, bulkhead, male, MIL type UG-1094/U Pan Part J2031	AD 31-221		
L401		TOROID, 4 mh, self resonance frequency above 400 kc Pan Part L3011	BY TA-2854MS	1	
L402		COIL: oscillator, 100-185 KC Pan Part ZN-8201	BD ZN-8201	1	
L403		CHOKE: filter, 8 henry, 100 ma Pan Part L2-10789	BD L2-10789	1	
L404		CHOKE: ferrite, 2.5 millihenry Pan Part L2019	BA 6302	1	
L405		CHOKE: ferrite, 500 microhenry Pan Part L2025	AZ J300-500	1	
P103		CONNECTOR: plug, male, MIL type UG-260/U Pan Part P2010	AD 31-012	8	
P104		CONNECTOR: plug, male, MIL type UG-260/U Pan Part P2010	AD 31-012		
P105		CONNECTOR: plug, male, MIL type UG-260/U Pan Part P2010	AD 31-012		
P106		CONNECTOR: plug, male, MIL type UG-260/U Pan Part P2010	AD 31-012		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
P108		CONNECTOR: plug, ten pin female Pan Part P2041	AD AN3106A18-1S	1	
R403		CONNECTOR: plug, male MIL type UG-260/U Pan Part P2010	AD 31-012		
R404		CONNECTOR: plug, male, MIL type UG-260/U Pan Part P2010	AD 31-012		
R405		CONNECTOR: plug, male, MIL type UG-260/U Pan Part P2010	AD 31-012		
P406		CONNECTOR: plug, male, MIL type UG-260/U Pan Part P2010	AD 31-012		
P408		CONNECTOR: plug, ten pin, male Pan Part 2036	AD AN3106A18-1P	2	
P410		CONNECTOR: plug, 24 pin, male Pan Part P2047	AD 26-410024P	1	
P415		CONNECTOR: plug, right angle BNC type male Pan Part P2051	BN 8575	5	
P416		CONNECTOR: plug, right angle BNC type, male Pan Part P2051	BN 8575		
P417		CONNECTOR: plug, right angle BNC type, male Pan Part P2051	BN 8575		
P418		CONNECTOR: plug, right angle BNC type, male Pan Part P2051	BN 8575		
P419		CONNECTOR: plug, right angle BNC type, male Pan Part P2051	BN 8575		
P421		CONNECTOR: plug, ten pin, male Pan Part P2036	AD AN3106A18-1P		
R403		RESISTOR: fixed, composition, 22 K, ±5%, 2 W Pan Part RC42BX223J	AB HB2235	6	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R404		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735	32	
R405		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R406		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R407		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R408		RESISTOR: fixed, composition, 22 K, ±5%, 2 W Pan Part RC42BX223J	AB HB2235		
R410		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045	11	
R411		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645	1	
R412		RESISTOR: fixed, composition, factory selected, 3.6 K, ±5%, 1/2 W, nominal value Pan Part RC20BX362J	AB EB3625	2	
R413		RESISTOR: fixed, composition, 22 K, ±5%, 2 W Pan Part RC42BX223J	AB HB2235		
R414		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R415		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R416		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R417		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R418		RESISTOR: fixed, composition, 22 K, ±5%, 2 W Pan Part RC42BX223J	AB HB2235		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R419		RESISTOR: fixed, composition, 330 K, ±5%, 1/2 W Pan Part RC20BX334J	AB EB3345	5	
R420		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R421		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445	2	
R422		RESISTOR: fixed, composition, factory selected, 3.6 K, ±5%, 1/2 W, nominal value Pan Part RC20BX362J	AB EB3625		
R423		RESISTOR: fixed, composition, 22K, ±5%, 2 W Pan Part RC42BX223J	AB HB2235		
R424		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R425		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R426		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R427		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R428		RESISTOR: fixed, composition, 22 K, ±5%, 2 W Pan Part RC42BX223J	AB HB2235		
R429		RESISTOR: fixed, composition, 330 K, ±5%, 1/2 W Pan Part RC20BX334J	AB EB3345		
R430		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035	3	
R431		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235	2	
R432		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R433		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R434		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R435		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R436		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R437		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R438		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R439		RESISTOR: fixed, composition, 2.2 meg., ±5%, 1/2 W Pan Part RC20BX225J	AB EB2255	7	
R440		RESISTOR: fixed, composition, factory selected, 33 K, ±5%, 1/2 W, nominal value Pan Part RC20BX333J	AB EB3335	3	
R441		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R442		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R443		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R444		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R445		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R446		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R447		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R448		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R449		RESISTOR: fixed, composition, 2.2 meg., ±5%, 1/2 W Pan Part RC20BX225J	AB EB2255		
R450		RESISTOR: fixed, composition, factory selected, 62 K, ±5%, 1/2 W, nominal value Pan Part RC20BX623J	AB EB6235	4	
R451		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R452		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R453		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R454		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R455		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R456		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R457		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R458		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R459		RESISTOR: fixed, composition, 2.2 meg., ±5%, 1/2 W Pan Part RC20BX225J	AB EB2255		
R460		RESISTOR: fixed, composition, factory selected, 75 K, ±5%, 1/2 W, nominal value Pan Part RC20BX753J	AB EB7535	1	

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R461		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R462		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R463		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R464		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R465		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R466		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R467		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R468		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R469		RESISTOR: fixed, composition, 2.2 meg., ±5%, 1/2 W Pan Part RC20BX225J	AB EB2255		
R470		RESISTOR: fixed, composition, factory selected, 100 K, ±5%, 1/2 W, nominal value Pan Part RC20BX104J	AB EB1045		
R471		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R472		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R473		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R474		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R475		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R476		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R477		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R478		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R479		RESISTOR: fixed, composition, 2.2 meg., ±5%, 1/2 W Pan Part RC20BX225J	AB EB2255		
R480		RESISTOR: fixed, composition, factory selected, 100 K, ±5%, 1/2 W, nominal value Pan Part RC20BX104J	AB EB1045		
R481		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R482		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		
R483		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R484		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2445		
R485		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164	AB EB1645		
R486		RESISTOR: fixed, composition, 160 K, ±5%, 1/2 W Pan Part RC20BX164J	AB EB1645		
R487		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB EB2445		
R488		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R489		RESISTOR: fixed, composition, 2.2 meg., ±5%, 1/2 W Pan Part RC20BX225J	AB EB2255		
R490		RESISTOR: fixed, composition, factory selected, 120 K, ±5%, 1/2 W, nominal value Pan Part RC20BX124J	AB EB1245		
R491		RESISTOR: fixed, composition, 150 K, ±5%, 1/2 W Pan Part RC20BX154J	AB EB1545	5	
R492		RESISTOR: fixed, composition, 150 K, ±5%, 1/2 W Pan Part RC20BX154J	AB EB1545		
R493		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035		
R580		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015	7	
R581		RESISTOR: fixed, composition, 15 K, ±5%, 1/2 W Pan Part RC20BX153J	AB EB1535	1	
R582		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015		
R583		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015		
R584		RESISTOR: fixed, composition, 270 K, ±5%, 1/2 W Pan Part RC20BX274J	AB EB2745	3	
R585		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R587		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235	2	
R588		RESISTOR: fixed, composition, 270 K, ±5%, 1/2 W Pan Part RC20BX274J	AB EB2745		
R590		RESISTOR: fixed, composition, 22 K, ±5%, 1/2 W Pan Part RC20BX223J	AB EB2235		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R591		RESISTOR: fixed, composition, 39 K, ±5%, 1 W Pan Part RC32BX393J	AB EB2935	1	
R592		RESISTOR: fixed, composition, 51 K, ±5%, 1/2 W Pan Part RC20BX513J	AB EB5135	2	
R593		RESISTOR: variable, composition, linear, 100,000 ohms, ±10%, 2 W Pan Part RV025	BD RV025	1	
R597		RESISTOR: fixed, composition, 1.5 meg, ±5%, 1/2 W Pan Part RC20BX155J	AB EB1555	2	
R598		RESISTOR: fixed, composition, 510 K, ±5%, 1/2 W Pan Part RC20BX514J	AB EB5145	4	
R599		RESISTOR: fixed, composition, 510 K, ±5%, 1/2 W Pan Part RC20BX514J	AB EB5145		
R600		RESISTOR: fixed, composition, 3.9 K, ±5%, 1 W Pan Part RC32BX392J	AB EB3925	1	
R601		RESISTOR: fixed, composition, 1.5 meg, ±5%, 1/2 W Pan Part RC20BX155J	AB EB1555		
R602		RESISTOR: fixed, composition, 1 meg, ±5%, 1/2 W Pan Part RC20BX105J	AB EB1055	4	
R603		RESISTOR: fixed, composition, 51 K, ±5%, 1/2 W Pan Part RC20BX513J	AB EB5135		
R604		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R605		RESISTOR: fixed, composition, 27 K, ±5%, 1 W Pan Part RC32BX273J	AB GB2735	1	
R606		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R608		RESISTOR: fixed, composition, 1.1 meg, ±5%, 1/2 W Pan Part RC20BX115J	AB EB1155	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R609		RESISTOR: variable, composition, linear, 500,000 ohms, ±10%, 2 W Pan Part RV015	BD RV015	2	
R610		RESISTOR: fixed, composition, 680 K, ±5%, 1/2 W Pan Part RC20BX684J	AB EB6845	2	
R611		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015		
R612		RESISTOR: fixed, composition, 200 K, ±5%, 1/2 W Pan Part RC20BX204J	AB EB2045	1	
R613		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R614		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R615		RESISTOR: fixed, composition, 220 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2245	3	
R616		RESISTOR: fixed, composition, 330 K, ±5%, 1/2 W Pan Part RC20BX334J	AB EB3345		
R617		RESISTOR: fixed, composition, 330 K, ±5%, 1/2 W Pan Part RC20BX334J	AB EB3345		
R618		RESISTOR: fixed, composition, 220 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2245		
R619		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R620		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035		
R621		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035		
R622		RESISTOR: fixed, composition, 1 meg, ±5%, 1/2 W Pan Part RC20BX105J	AB EB1055		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R623		RESISTOR: fixed, composition, 1.2 K, ±5%, 1/2 W Pan Part RC20BX122J	AB EB1225	1	
R624		RESISTOR: fixed, composition, 4.7 K, ±5%, 1/2 W Pan Part RC20BX472J	AB EB4725	2	
R625		RESISTOR: fixed, composition, 150 K, ±5%, 1 W Pan Part 32BX154J	AB GB1545	1	
R626		RESISTOR: fixed, composition, 2.2 K, ±5%, 1/2 W Pan Part RC20BX222J	AB EB2225	2	
R627		RESISTOR: fixed, composition, 680 K, ±5%, 1/2 W Pan Part RC20BX684J	AB EB6845		
R628		RESISTOR: fixed, composition, 62 K, ±5%, 1/2 W Pan Part RC20BX623J	AB EB6235		
R629		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015		
R645		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R646		RESISTOR: fixed, wirewound, flat, 2500 ohms, 22 W Pan Part RW21G252R	BR RW21G252	1	
R647		RESISTOR: fixed, wirewound, tubular, axial leads, 7000 ohms, ±5%, 5 W Pan Part RW5X702A-4	BR 5X7000WL	1	
R648		RESISTOR: fixed, wirewound, 700 ohms, ±5%, 5 W Pan Part RW5X701A-1	BG Type 27E	1	
R649		RESISTOR: fixed, wirewound, flat, 800 ohms, 15 W Pan Part RW20G801R	BR RW20G801	1	
R650		RESISTOR: fixed, wirewound, 900 ohms, ±5%, 5 W Pan Part RW5X901A-1	BG Type 27E	1	
R652		RESISTOR: fixed, wirewound, flat, 100 ohms, 15 W Pan Part RW20G101R	BR RW20G101	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R653		RESISTOR: fixed, composition, 10 K, ±5%, 1/2 W Pan Part RC20BX103J	AB EB1035		
R654		RESISTOR: fixed, composition, 13 K, ±5%, 2 W Pan Part RC42BX133J	AB HB1335	1	
R655		RESISTOR: fixed, composition, 4.7 meg, ±5%, 1/2 W Pan Part RC20BX475J	AB EB4755	1	
R656		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R657		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R658		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R659		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R660		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R661		RESISTOR: fixed, composition, 220 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2245		
R662		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R663		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R664		RESISTOR: fixed, composition, 150 K, ±5%, 1/2 W Pan Part RC20BX154J	AB EB1545		
R665		RESISTOR: fixed, composition, 1 meg, ±5%, 1/2 W Pan Part RC20BX105J	AB EB1055		
R666		RESISTOR: fixed, composition, 33 K, ±5%, 1/2 W Pan Part RC20BX333J	AB EB3335		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R667		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735	5	
R668		RESISTOR: fixed, composition, 330 K, ±5%, 1/2 W Pan Part RC20BX334J	AB EB3345	2	
R669		RESISTOR: fixed, composition, 27 K, ±5%, 1/2 W Pan Part RC20BX273J	AB EB2735	1	
R670		RESISTOR: fixed, composition, 150 K, ±5%, 1 W Pan Part RC32BX154J	AB EB1545	1	
R671		RESISTOR: fixed, composition, 62 K, ±5%, 1/2 W Pan Part RC20BX623J	AB EB6235		
R672		RESISTOR: fixed, composition, 8.2 K, ±5%, 1/2 W Pan Part RC20BX822J	AB EB8225	2	
R673		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R674		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R675		RESISTOR: fixed, composition, 3.9 K, ±5%, 1/2 W Pan Part RC20BX392J	AB EB3925	2	
R676		RESISTOR: variable, composition, linear, 1000 ohms, ±10%, 2 W Pan Part RV018	BD RV018	1	
R677		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745	4	
R678		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		
R679		RESISTOR: fixed, composition, 47 K, ±5%, 1/2 W Pan Part RC20BX473J	AB EB4735		
R680		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R681		RESISTOR: fixed, composition, 470 K, ±5%, 1/2 W Pan Part RC20BX474J	AB EB4745		
R682		RESISTOR: fixed, composition, 3.9 K, ±5%, 1/2 W Pan Part RC20BX392J	AB EB3925		
R683		RESISTOR: variable, composition, CW taper, 50 K, ±10%, 2 W Pan Part RV038	BD RV038	1	
R684		RESISTOR: fixed, composition, 1 meg, ±5%, 1/2 W Pan Part RC20BX105J	AB EB1055		
R685		RESISTOR: fixed, composition, 470 ohms, ±5%, 1/2 W Pan Part RC20BX471J	AB EB4715	2	
R686		RESISTOR: fixed, composition, 2.2 K, ±5%, 1/2 W Pan Part RC20BX222J	AB EB2225		
R687		RESISTOR: fixed, composition, 220 K, ±5%, 1/2 W Pan Part RC20BX224J	AB EB2245		
R688		RESISTOR: variable, composition, linear, 25,000 ohms, ±10%, 2 W Pan Part RV026	BD RV026	1	
R689		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015		
R801		RESISTOR: fixed, composition, factory selected, 5.6 K, ±5%, 1/2 W, nominal value Pan Part RC20BX562J	AB EB5625	1	
R802		RESISTOR: fixed, composition, factory selected, 6.2 K, ±5%, 1/2 W, nominal value Pan Part RC20BX622J	AB EB6225	2	
R803		RESISTOR: fixed, composition, factory selected, 6.8 K, ±5%, 1/2 W, nominal value Pan Part RC20BX682J	AB EB6825	1	
R804		RESISTOR: variable, wirewound, miniature, 25K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00	20	

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R805		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R806		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R807		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R808		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R809		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R810		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R811		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R812		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R813		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R814		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R815		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R816		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R817		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R818		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfr. No.	Qty. In Set	Qty. 3 Mo. Opn.
R819		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R820		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R821		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R822		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R823		RESISTOR: variable, wirewound, miniature, 25 K, ±5%, 1 W Pan Part RVA-M-1002	BS Type 300-00		
R824		RESISTOR: fixed, composition, 240 K, ±5%, 1/2 W Pan Part RC20BX244J	AB RC20GF244J		
R825		RESISTOR: fixed, composition, factory selected, 820 K, ±5%, 1/2 W, nominal value Pan Part RC20BX824J	AB EB8245		
R826		RESISTOR: fixed, composition, factory selected, 620 K, ±5%, 1/2 W, nominal value Pan Part RC20BX624J	AB EB6245	2	
R827		RESISTOR: fixed, composition, factory selected, 620 K, ±5%, 1/2 W, nominal value Pan Part RC20BX624J	AB EB6245		
R828		RESISTOR: fixed, composition, factory selected, 510 K, ±5%, 1/2 W, nominal value Pan Part RC20BX514J	AB EB5145		
R829		RESISTOR: fixed, composition, factory selected, 510 K, ±5%, 1/2 W, nominal value Pan Part RC20BX514J	AB EB5145		
R830		RESISTOR: fixed, composition, factory selected, 330 K, ±5%, 1/2 W, nominal value Pan Part RC20BX334J	AB EB3345		
R831		RESISTOR: fixed, composition, factory selected, 270 K, ±5%, 1/2 W, nominal value Pan Part RC20BX274J	AB EB2745		

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R832		RESISTOR: fixed, composition, factory selected, 180 K, ±5%, 1/2 W, nominal value Pan Part RC20BX184J	AB EB1845		
R833		RESISTOR: fixed, composition, factory selected, 150 K, ±5%, 1/2 W, nominal value Pan Part RC20BX154	AB EB1545		
R834		RESISTOR: fixed, composition, factory selected, 91 K, ±5%, 1/2 W, nominal value Pan Part RC20BX913J	AB EB9135	1	
R835		RESISTOR: fixed, composition, factory selected, 62 K, ±5%, 1/2 W, nominal value Pan Part RC20BX623J	AB EB6235		
R836		RESISTOR: fixed, composition, factory selected, 47 K, ±5%, 1/2 W, nominal value Pan Part RC20BX473J	AB EB4735		
R837		RESISTOR: fixed, composition, factory selected, 33 K, ±5%, 1/2 W, nominal value Pan Part RC20BX333J	AB EB3335		
R838		RESISTOR: fixed, composition, factory selected, 24 K, ±5%, 1/2 W, nominal value Pan Part RC20BX243J	AB EB2435	1	
R839		RESISTOR: fixed, composition, factory selected, 9.1 K, ±5%, 1/2 W, nominal value Pan Part RC20BX912J	AB EB9125	1	
R840		RESISTOR: fixed, composition, factory selected, 20 K, ±5%, 1/2 W, nominal value Pan Part RC20BX203J	AB EB2035	1	
R841		RESISTOR: fixed, composition, factory selected, 7.5 K, ±5%, 1/2 W, nominal value Pan Part RC20BX752J	AB EB7525	1	
R842		RESISTOR: fixed, composition, factory selected, 16 K, ±5%, 1/2 W, nominal value Pan Part RC20BX163J	AB EB1635	1	

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R843		RESISTOR: fixed, composition, factory selected, 6.2 K, ±5%, 1/2 W, nominal value Pan Part RC20BX622J	AB EB6225		
R844		RESISTOR: fixed, composition, factory selected, 13 K, ±5%, 1/2 W, nominal value Pan Part RC20BX133J	AB EB1335	1	
R845		RESISTOR: fixed, composition, factory selected, 5.1 K, ±5%, 1/2 W, nominal value Pan Part RC20BX512J	AB EB5125	2	
R846		RESISTOR: fixed, composition, factory selected, 1.5 K, ±5%, 1/2 W, nominal value Pan Part RC20BX153J	AB EB1535	1	
R847		RESISTOR: fixed, composition, factory selected, 5.1 K, ±5%, 1/2 W, nominal value Pan Part RC20BX512J	AB EB5125		
R848		RESISTOR: fixed, composition, 10 K, ±5%, 1 W Pan Part RC32BX103J	AB GB1035	1	
R849		RESISTOR: fixed, composition, 270 K, ±5%, 1 W Pan Part RC32BX274J	AB GB2745	1	
R850		RESISTOR: fixed, composition, 150 K, ±5%, 1/2 W Pan Part RC20BX154J	AB EB1545		
R851		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R852		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		
R853		RESISTOR: variable, composition, linear, 500,000 ohms, ±10%, 2 W Pan Part RV015	BD RV015		
R854		RESISTOR: fixed, composition, 100 K, ±5%, 1/2 W Pan Part RC20BX104J	AB EB1045		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R855		RESISTOR: variable, composition, linear, 2.5 meg, ±20%, 2 W Pan Part RV039	BD RV039	1	
R856		RESISTOR: fixed, composition, 3.3 meg, ±5%, 1/2 W Pan Part RC20BX335J	AB EB3355	1	
R857		RESISTOR: fixed, composition, 270 K, ±5%, 1/2 W Pan Part RC20BX274J	AB EB2745		
R858		RESISTOR: fixed, composition, 47 K, ±5%, 2 W Pan Part RC42BX473J	AB HB4735	2	
R859		RESISTOR: fixed, composition, 47 K, ±5%, 2 W Pan Part RC42BX473J	AB HB4735		
R860		RESISTOR: fixed, composition, 33 K, ±5%, 2 W Pan Part RC42BX333J	AB HB3335	2	
R861		RESISTOR: fixed, composition, 33 K, ±5%, 2 W Pan Part RC42BX333J	AB HB3335		
R862		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AB EB1015		
R863		RESISTOR: fixed, composition, 240 ohms, ±5%, 1/2 W Pan Part RC20BX241J	AB EB2415	1	
R864		RESISTOR: fixed, composition, 470 K, ±5%, 1 W Pan Part RC32BX474J	AB GB4745	1	
R865		RESISTOR: fixed, composition, 36 K, ±5%, 1/2 W Pan Part RC20BX363J	AB EB3635	1	
R866		RESISTOR: fixed, composition, 8.2 K, ±5%, 1/2 W Pan Part RC20BX822J	AB EB8225		
R867		RESISTOR: fixed, composition, 33 K, ±5%, 1 W Pan Part RC32BX333J	AB GB3335	1	
R868		RESISTOR: fixed, composition, 2.2 meg, ±5%, 1/2 W Pan Part RC20BX225J	AB EB2255	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R869		RESISTOR: fixed, composition, 470 ohms, ±5%, 1/2 W Pan Part RC20BX471J	AB EB4715		
R870		RESISTOR: fixed, composition, 4.7 K, ±5%, 1/2 W Pan Part RC20BX472J	AB EB4725		
R871		RESISTOR: fixed, composition, 1.2 K, ±5%, 1 W Pan Part RC32BX122J	AB GB1225	1	
S401		SWITCH: rotary, selector, 9 pole, 24 position Pan Part S3-10217A	BD S3-10217A	1	
S402		SWITCH: rotary, selector, 6P-5T, ceramic, 3 wafers, non-shorting Pan Part S1-9424B	BD S1-9424B	1	
S403		SWITCH: toggle, SPST Pan Part S2052	AL ST42A	1	
T401		TRANSFORMER: pulse, B.T.O. Pan Part T2-10790A	BD T2-10790A	1	
T402		TRANSFORMER: power, low voltage Pan Part T3-9875D	BD T3-9875D	1	
T403		TRANSFORMER: filament Pan Part T3022	BD T3022	1	
T404		TRANSFORMER: constant, voltage, 250 VA Pan Part T3017-2	BD T3017-2	1	
V401		ELECTRON TUBE: 5964 Pan Part 5964	BK 5964	3	
V402		ELECTRON TUBE: 5964 Pan Part 5964	BK 5964		
V403		ELECTRON TUBE: 5964 Pan Part 5964	BK 5964		
V404		ELECTRON TUBE: 5844 Pan Part 5844	BK 5844	8	
V405		ELECTRON TUBE: 5844 Pan Part 5844	BK 5844		
V406		ELECTRON TUBE: 5844 Pan Part 5844	BK 5844		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
V407		ELECTRON TUBE: 5844 Pan Part 5844	BK 5844		
V408		ELECTRON TUBE: 5844 Pan Part 5844	BK 5844		
V409		ELECTRON TUBE: 5844 Pan Part 5844	BK 5844		
V410		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA	9	
V411		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA		
V412		ELECTRON TUBE: 5814 or 5814A Pan Part 5814 or 5814A	BK 5814 or 5814A	1	
V413		ELECTRON TUBE: 5844 Pan Part 5844	BK 5844		
V414		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA		
V415		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA		
V416		ELECTRON TUBE: 5R4GY Pan Part 5R4GY	BK 5R4GY	1	
V417		ELECTRON TUBE: OA2 Pan Part OA2	BK OA2	1	
V418		ELECTRON TUBE: OA3 Pan Part OA3	BK OA3	1	
V419		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA		
V420		ELECTRON TUBE: 5844 Pan Part 5844	BK 5844		
V421		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA		
V422		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA		

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
V423		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA		
V424		ELECTRON TUBE: 6AL5 Pan Part 6AL5	BK 6AL5	1	
V425		ELECTRON TUBE: 12AT7 or 12AT7WA Pan Part 12AT7 or 12AT7WA	BK 12AT7 or 12AT7WA		
XF401		FUSE HOLDER: extractor type Pan Part 2010	AY 342003	2	
XF402		FUSE HOLDER: extractor type Pan Part 2010	AY 342003		
XI403		LAMP HOLDER: pilot lamp Pan Part B2038	AN 93410-112	1	
Y401		CRYSTAL: Quartz, 220.160 KC Pan Part Y3007/1/+7.5	BD Y3007/1/+7.5	1	
Y402		CRYSTAL: Quartz, 308.224 KC Pan Part Y3007/2/+7.5	BD Y3007/2/+7.5	1	
Y403		CRYSTAL: Quartz, 401.920 KC Pan Part Y3007/3/+7.5	BD Y3007/3/+7.5	1	
Y404		CRYSTAL: Quartz, 264.192 KC Pan Part Y3007/4/+7.5	BD Y3007/4/+7.5	1	
Y405		CRYSTAL: Quartz, 357.888 KC Pan Part Y3007/5/+7.5	BD Y3007/5/+7.5	1	
Y406		CRYSTAL: Quartz, 233.984 KC Pan Part Y3007/6/+7.5A	BD Y3007/6/+7.5A	1	
Y407		CRYSTAL: Quartz, 316.544 KC Pan Part Y3007/7/+7.5	BD Y3007/7/+7.5	1	
Y408		CRYSTAL: Quartz, 412.800 KC Pan Part Y3007/8/+7.5A	BD Y3007/8/+7.5A	1	
Y409		CRYSTAL: Quartz, 268.352 KC Pan Part Y3007/9/+7.5	BD Y3007/9/+7.5	1	
Y410		CRYSTAL: Quartz, 371.520 KC Pan Part Y3007/10/+7.5	BD Y3007/10/+7.5	1	
Y411		CRYSTAL: Quartz, 252.832 KC Pan Part Y3007/11/+7.5	BD Y3007/11/+7.5	1	
Y412		CRYSTAL: Quartz, 361.216 Pan Part Y3007/12/+7.5	BD Y3007/12/+7.5	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
Y413		CRYSTAL: Quartz, 249.408 KC Pan Part Y3007/13/+7.5	BD Y3007/13/+7.5	1	
Y414		CRYSTAL: Quartz, 378.400 KC Pan Part Y3007/14/+7.5	BD Y3007/14/+7.5	1	
Y415		CRYSTAL: Quartz, 404.800 KC Pan Part Y3007/A/+15	BD Y3007/A/+15	1	
Y416		CRYSTAL: Quartz, 258.000 KC Pan Part Y3007/15/+7.5	BD Y3007/15/+7.5	1	
Y417		CRYSTAL, Quartz, 276.000 KC Pan Part Y3007/B/+15	BD Y3007/B/+15	1	
Y418		CRYSTAL: Quartz, 344.000 KC Pan Part Y3007/16/+7.5	BD Y3007/16/+7.5	1	
Y419		CRYSTAL: Quartz, 368.000 KC Pan Part Y3007/C/+15	BD Y3007/C/+15	1	
Y420		CRYSTAL: Quartz, 225.760 KC Pan Part Y3007/17/+7.5A	BD Y3007/17/+7.5A	1	
Y421		CRYSTAL: Quartz, 241.520 KC Pan Part Y3007/D/+15A	BD Y3007/D/+15A	1	
Y422		CRYSTAL: Quartz, 301.000 KC Pan Part Y3007/18/+7.5	BD Y3007/18/+7.5	1	
Y423		CRYSTAL: Quartz, 322.000 KC Pan Part Y3007/E/+15	BD Y3007/E/+15	1	
Y426		CRYSTAL: Quartz, 204.800 KC Pan Part Y3007/1/0	BD Y3007/1/0	1	
Y427		CRYSTAL: Quartz, 286.720 KC Pan Part Y3007/2/0	BD Y3007/2/0	1	
Y428		CRYSTAL: Quartz, 373.760 KC Pan Part Y3007/3/0	BD Y3007/3/0	1	
Y429		CRYSTAL: Quartz, 245.760 KC Pan Part Y3007/4/0	BD Y3007/4/0	1	
Y430		CRYSTAL: Quartz, 332.800 KC Pan Part Y3007/5/0	BD Y3007/5/0	1	
Y431		CRYSTAL: Quartz, 217.600 KC Pan Part Y3007/6/OA	BD Y3007/6/OA	1	
Y432		CRYSTAL: Quartz, 294.400 KC Pan Part Y3007/7/0	BD Y3007/7/0	1	
Y433		CRYSTAL: Quartz, 384.000 KC Pan Part Y3007/8/0	BD Y3007/8/0	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
Y434		CRYSTAL: Quartz, 249.600 KC Pan Part Y3007/9/0	BD Y3007/9/0	1	
Y435		CRYSTAL: Quartz, 345.600 KC Pan Part Y3007/10/0	BD Y3007/10/0	1	
Y436		CRYSTAL: Quartz, 235.200 KC Pan Part Y3007/11/0	BD Y3007/11/0	1	
Y437		CRYSTAL: Quartz, 336.000 KC Pan Part Y3007/12/0	BD Y3007/12/0	1	
Y438		CRYSTAL: Quartz, 232.000 KC Pan Part Y2007/13/0	BD Y3007/13/0	1	
Y439		CRYSTAL: Quartz, 352.000 KC Pan Part Y3007/14/0	BD Y3007/14/0	1	
Y440		CRYSTAL: Quartz, 240.000 KC Pan Part Y3007/15/0	BD Y3007/15/0	1	
Y441		CRYSTAL: Quartz, 320.000 KC Pan Part Y3007/16/0	BD Y3007/16/0	1	
Y442		CRYSTAL: Quartz, 210.000 KC Pan Part Y3007/17/0A	BD Y3007/17/0A	1	
Y443		CRYSTAL: Quartz, 280.000 KC Pan Part Y3007/18/0	BD Y3007/18/0	1	
Y451		CRYSTAL: Quartz, 189.440 KC Pan Part Y3007/1/-7.5	BD Y3007/1/-7.5	1	
Y452		CRYSTAL: Quartz, 265.216 KC Pan Part Y3007/2/-7.5	BD Y3007/2/-7.5	1	
Y453		CRYSTAL: Quartz, 345.600 KC Pan Part Y3007/3/-7.5	BD Y3007/3/-7.5	1	
Y454		CRYSTAL: Quartz, 227.328 KC Pan Part Y3007/4/-7.5	BD Y3007/4/-7.5	1	
Y455		CRYSTAL: Quartz, 307.712 KC Pan Part Y3007/5/-7.5	BD Y3007/5/-7.5	1	
Y456		CRYSTAL: Quartz, 201.216 KC Pan Part Y3007/6/-7.5A	BD Y3007/6/-7.5A	1	
Y457		CRYSTAL: Quartz, 272.256 KC Pan Part Y3007/7/-7.5	BD Y3007/7/-7.5	1	
Y458		CRYSTAL: Quartz, 355.200 KC Pan Part Y3007/8/-7.5	BD Y3007/8/-7.5	1	
Y459		CRYSTAL: Quartz, 230.848 KC Pan Part Y3007/9/-7.5	BD Y3007/9/-7.5	1	

List of Replaceable Parts for Model TMC-1a (continued)

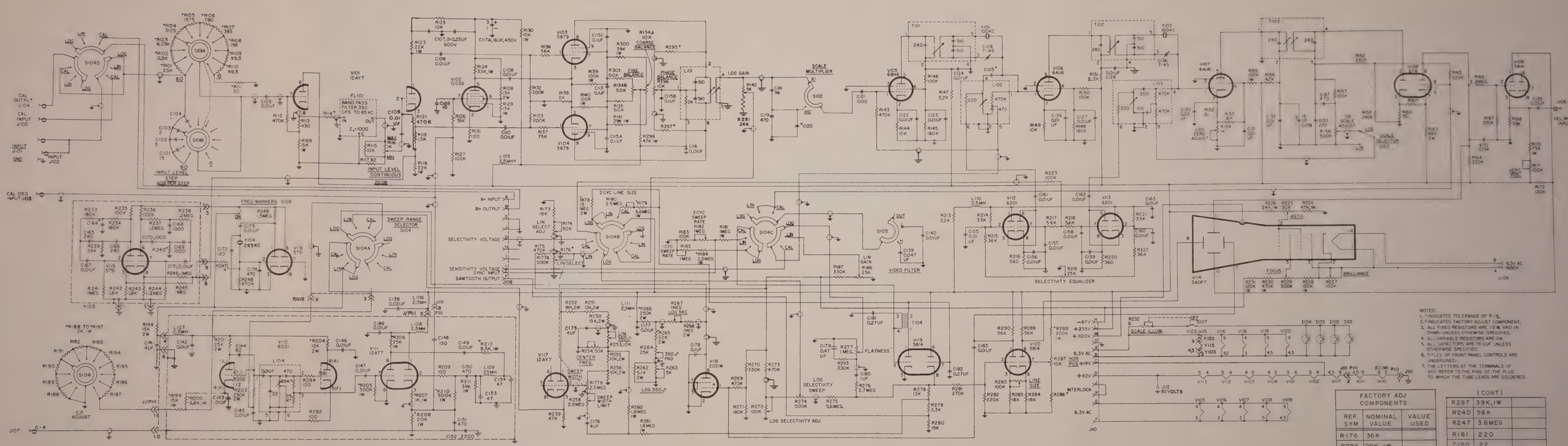
Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
Y460		CRYSTAL: Quartz, 319.680 KC Pan Part Y3007/10/-7.5	BD Y3007/10/-7.5	1	
Y461		CRYSTAL: Quartz, 217.568 KC Pan Part Y3007/11/-7.5	BD Y3007/11/-7.5	1	
Y462		CRYSTAL: Quartz, 310.784 KC Pan Part Y3007/12/-7.5	BD Y3007/12/-7.5	1	
Y463		CRYSTAL: Quartz, 214.592 KC Pan Part Y3007/13/-7.5	BD Y3007/13/-7.5	1	
Y464		CRYSTAL: Quartz, 325.600 KC Pan Part Y3007/14/-7.5	BD Y3007/14/-7.5	1	
Y465		CRYSTAL: Quartz, 299.200 KC Pan Part Y3007/A/-15	BD Y3007/A/-15	1	
Y466		CRYSTAL: Quartz, 222.000 KC Pan Part Y3007/15/-7.5	BD Y3007/15/-7.5	1	
Y467		CRYSTAL: Quartz, 204.000 KC Pan Part Y3007/B/-15	BD Y3007/B/-15	1	
Y468		CRYSTAL: Quartz, 296.000 KC Pan Part Y3007/16/-7.5	BD Y3007/16/-7.5	1	
Y469		CRYSTAL: Quartz, 272.000 KC Pan Part Y3007/C/-15	BD Y3007/C/-15	1	
Y470		CRYSTAL: Quartz, 194.240 KC Pan Part Y3007/17/-7.5A	BD Y3007/17/-7.5A	1	
Y471		CRYSTAL: Quartz, 178.480 KC Pan Part Y3007/D/-15A	BD Y3007/D/-15A	1	
Y472		CRYSTAL: Quartz, 259.000 KC Pan Part Y3007/18/-7.5	BD Y3007/18/-7.5	1	
Y473		CRYSTAL: Quartz, 238.000 KC Pan Part Y3007/E/-15	BD Y3007/E/-15	1	
Z401		ASSEMBLY: Plug-in High Frequency Divider, Octal base Pan Dwg. Z2-10388	BD Z2-10388	1	
Z402		ASSEMBLY: Plug-in Medium Frequency Divider, Octal base Pan Dwg. Z2-10387-1	BD Z2-10387-1	1	
Z403		ASSEMBLY: Plug-in Medium Frequency Divider, Octal base Pan Dwg. Z2-10387-2	BD Z2-10387-2	1	
Z404		ASSEMBLY: Plug-in Low Frequency Divider, Octal base Pan Dwg. Z2-10386-1	BD Z2-10386-1	1	

List of Replaceable Parts for Model TMC-1a (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
Z405		ASSEMBLY: Plug-in, Low Frequency Divider, Octal base Pan Dwg. Z2-10386-2	BD Z2-10386-2	1	
Z406		ASSEMBLY: Plug-in Low Frequency divider, Octal base Pan Dwg. Z2-10386-3	BD Z2-10386-3	1	
Z407		ASSEMBLY: Plug-in Low Frequency Divider, Octal base Pan Dwg. Z2-10386-4	BD Z2-10386-4	1	
Z408		ASSEMBLY: Plug-in Low Frequency Divider, Octal base Pan Dwg. Z2-10386-5	BD Z2-10386-5	1	
Z409		ASSEMBLY: Plug-in Low Frequency Divider, Octal base Pan Dwg. Z2-10386-6	BD Z2-10386-6	1	
Z413		ASSEMBLY: Plug-in First Control Divider, 11 pin octal type base Pan Dwg. Z2-10389	BD Z2-10389	1	
Z420		ASSEMBLY: Plug-in Second Control Divider, Octal base Pan Dwg. Z2-10390	BD Z2-10390	1	
		WRENCH: #6 Allen Pan Part E1009A	AC 116	1	
		WRENCH: #8 Allen Pan Part E1009	AC 564	1	
		WRENCH: #10 Allen Pan Part E1009B	AC 332	1	
		TOOL: Alignment Pan Part E1010	BD E1010	1	
		TOOL: screwdriver, jeweler's 1/16" blade Pan Part E2009	BP 555B	1	

LIST OF MANUFACTURERS CODE LETTERS

AA	Aerovox Corporation
AB	Allen-Bradley Company
AC	Allen Manufacturing Company, Hartford, Connecticut
AD	Amphenol Electronics Corporation
AE	Birnbach Radio Company
AF	Borg Equipment, Division of George W. Borg Corporation
AG	Bussman Manufacturing Company
AH	Centralab, Division of Globe-Union, Inc.
AI	Cinch Manufacturing Corporation
AJ	Continental Carbon Company, Inc.
AK	Cornell-Dubilier Electric Corporation
AL	Cutler-Hammer, Inc.
AM	De Jur Amsco Corporation
AN	Dial Light Company of America, Inc.
AO	DuMont, Allen B., Laboratories, Inc.
AP	Elco Corporation
AQ	Electro Motive Manufacturing Company
AR	Erie Resistor Corporation
AS	General Electric Company
AT	General Transformer Company
AU	Hardwick Hindle, Inc.
AV	Hubbell, Harvey, Inc.
AW	Hycor Company, Inc.
AX	International Rectifier Corporation
AY	Littlefuse, Inc.
AZ	Millen, James, Manufacturing Company, Inc.
BA	Miller, J. W., Company
BB	National Company, Inc.
BC	Oak Manufacturing Company
BD	Panoramic Electronics Inc.
BE	Pyramid Electric Company
BF	Radio Receptor Company, Inc.
BG	Sprague Products Company
BH	Stanley Transformer Company
BI	Vector Electronic Company
BJ	E. F. Johnson Company
BK	Any tube having RETMA characteristics.
BL	Allen D. Cardwell Company
BM	Hammarlund Manufacturing Company, Inc.
BN	Industrial Products Corporation
BO	Hoffman Electronics Corporation
BP	L. S. Starrett Company
BQ	Eldema Corporation
BR	Ward Leonard Electric Company
BS	Daystrom Pacific
BT	Fluorocarbon Products, Inc.
BU	Solar Electric Company
BW	Augat Bros.
BX	Hudson Lamp Company
BY	Torotron Corporation, Div. of Douglas Microwave Co., Inc.
CA	Gudeman Company
CB	CTS Corporation



NOTES:
1. *INDICATES TOLERANCE OF ±1%.
2. †INDICATES FACTORY ADJUST COMPONENT.
3. ALL FIXED RESISTORS ARE 1/2 W, AND IN OHMS UNLESS OTHERWISE SPECIFIED.
4. ALL VARIABLE RESISTORS ARE 2W.
5. ALL CAPACITORS ARE IN UUF UNLESS OTHERWISE SPECIFIED.
6. TITLES OF FRONT PANEL CONTROLS ARE UNDERLINED.
7. THE LETTERS AT THE TERMINALS OF V110 REFER TO THE PINS OF THE PLUG TO WHICH THE TUBE LEADS ARE SOLDERED.

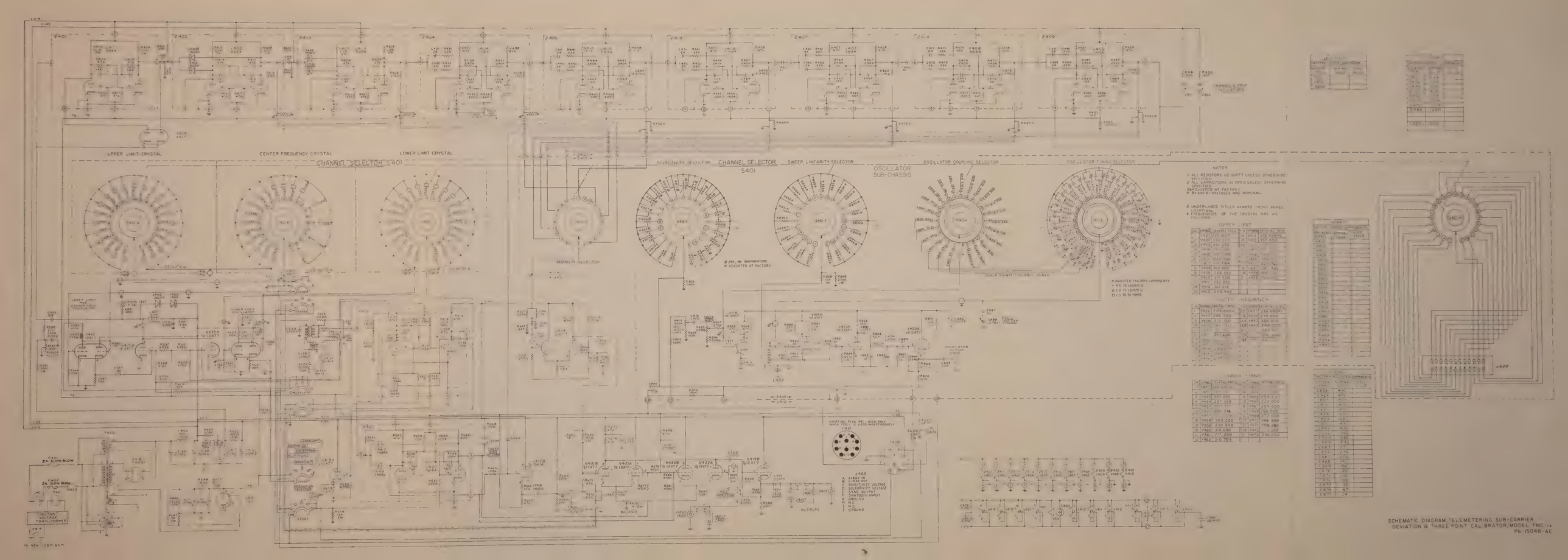
FACTORY ADJ COMPONENTS

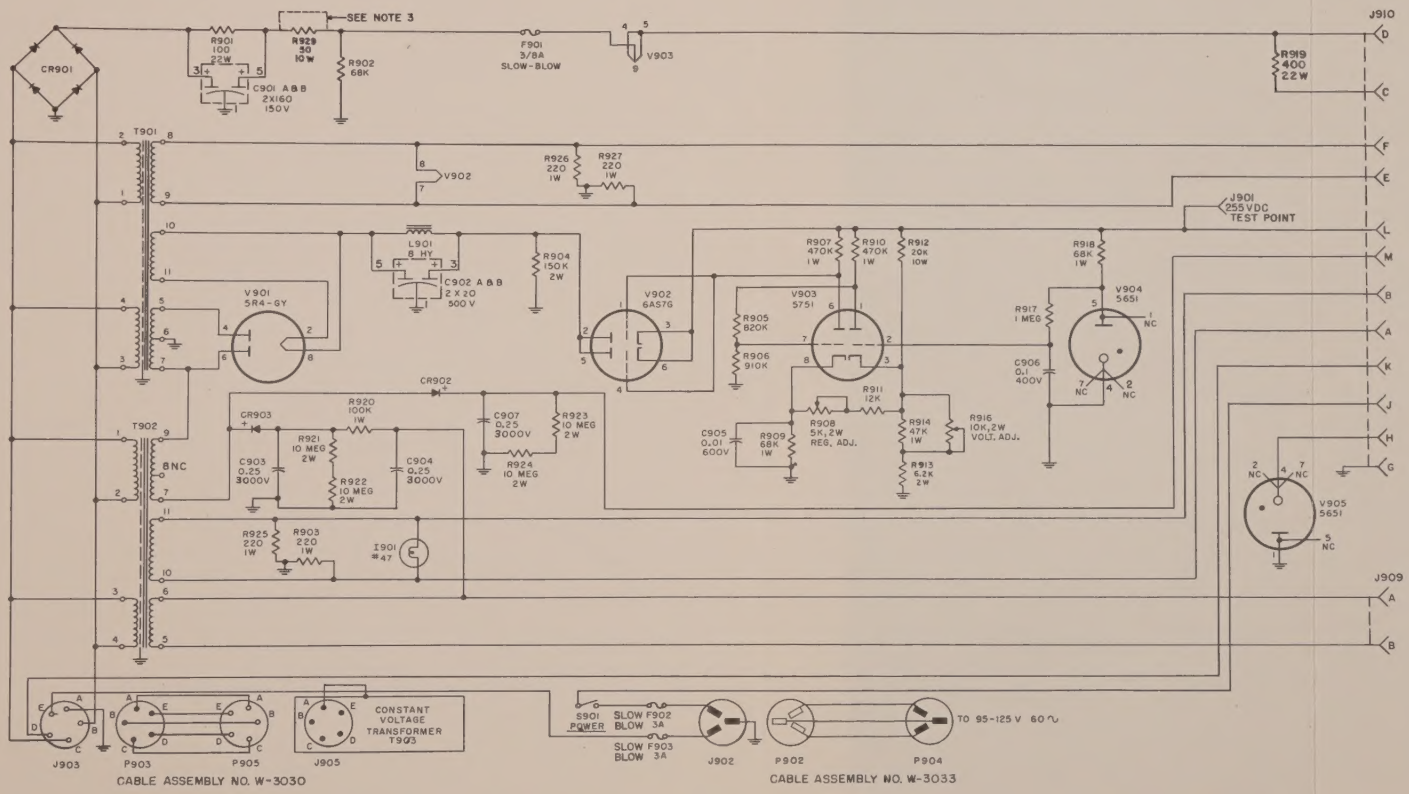
REF. SYM	NOMINAL VALUE	VALUE USED
R176	36K	
R286	20K, 1W	
R114	510	
R295	39K, 1W	

(CONT)

R297	39K, 1W	
R240	56K	
R247	3.6MEG	
R161	220	
C120	22	
C125	820	
C164	470	

TELEMETERING INDICATOR SCHEMATIC 556155-046 23


CHANNEL SELECTOR S401
UPPER LIMIT CRYSTAL
CENTER FREQUENCY CRYSTAL
LOWER LIMIT CRYSTAL
SENSITIVITY SELECTOR
CHANNEL SELECTOR S401
SWEEP LINEARITY SELECTOR
OSCILLATOR SUB-CHASSIS
OSCILLATOR COUPLING SELECTOR
OSCILLATOR TUNING SELECTOR
MARKER SELECTOR
CHANNEL OUTPUT CONNECTORS
NOTES
1 ALL RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED.
2 ALL CAPACITORS IN MMFD UNLESS OTHERWISE SPECIFIED.
3 ADJUSTED AT FACTORY
4 B+ AND B- VOLTAGES ARE NOMINAL.
5 UNDERLINED TITLES DENOTE FRONT PANEL LOCATIONS.
6 FREQUENCIES OF THE CRYSTAL ARE AS FOLLOWS:
UPPER LIMIT
CENTER FREQUENCY
LOWER LIMIT
FACTORY ADJUSTED COMPONENTS
J408
A 115 V AC
B 115 V AC
C SENSITIVITY VOLTAGE
D SELECTIVITY VOLTAGE
E SYNC OUTPUT
F SAWTOOTH INPUT
G NO CONNECTION
H N.C.
J GROUND
J420
SCHEMATIC DIAGRAM, TELEMETERING SUB-CARRIER DEVIATION & "FREE POINT" CALIBRATOR, MODEL TMC-1A
P6-15048-AE



NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE 1/2 WATT AND ALL CAPACITORS ARE IN UF
2. FRONT PANEL CONTROL TITLES ARE UNDERLINED
3. R929 SHORTED OUT WHEN SOLA LINE REGULATOR IS USED

POWER SUPPLY, Panoramic TELEMETERING INDICATOR, Model TMI-1b, Schematic Diagram

11-556155-047